

## THE ILLUMINATING ENGINEER

LIGHT  
LAMPS  
FITTINGS  
AND  
ILLUMINATION

THE JOURNAL OF  
**GOOD LIGHTING**

Official Organ of the Illuminating Engineering Society

FOUNDED IN LONDON 1908

Edited by  
**LEON GASTER**

OIL  
GAS  
ELECTRICITY  
ACETYLENE  
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ETC.

Vol. XVIII

August, 1925

Price NINEPENCE

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For Foreign Countries, 15/- per annum.

### Special Features :

The Relation between Intensity of Illumination and Speed of Work—A Course on Illuminating Engineering—The Electric Lighting of Paris—Lighting Developments in Czecho-Slovakia — Notes on Electric Lamps — Gas Lighting Fittings in the Modern Home, etc.



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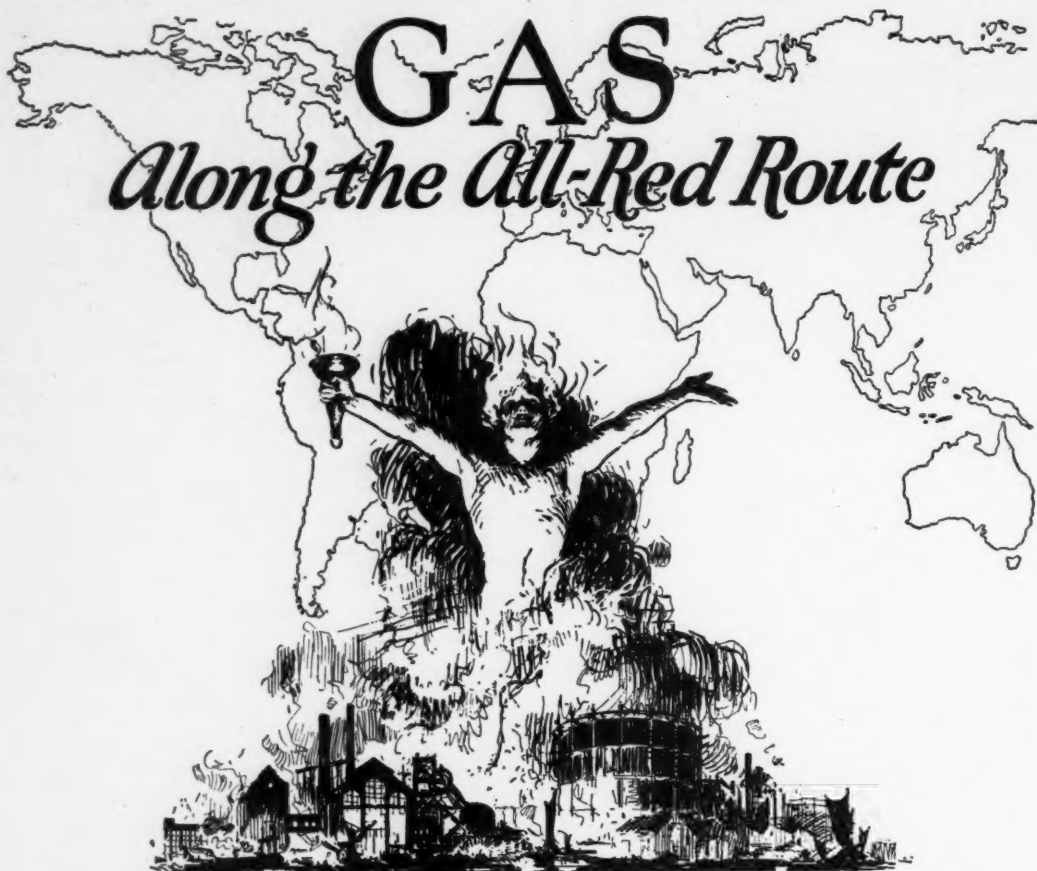
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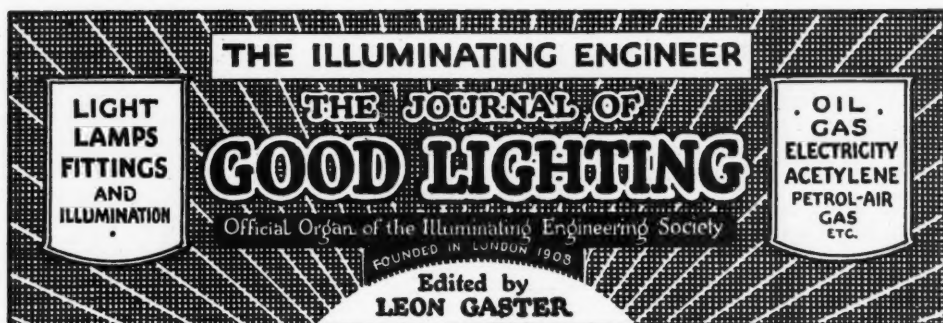
All these and many other things are illustrated by "Living Tableaux," cookery demonstrations with Empire food products, moving machinery or daylight cinema in the British Empire Gas Exhibit, Wembley, 1925.

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Tel. No.: Victoria 5215

## The Relation between Intensity of Illumination and Speed of Work

THE further communication from Dr. J. E. Ives, of the United States Public Health Service, which we deal with on pp. 211-213, forms an interesting supplement to the investigations on the illumination of post offices, summarized in our April issue. This former investigation indicated clearly that an advance from 3.6 to 8 foot-candles would result in a material gain in efficiency, conservatively assessed at 4.4 per cent. The present communication describes more detailed confirmatory experiments on this point. It is not easy to collect data showing the effect of better lighting on efficiency. It is also necessary to understand clearly what "efficiency" means and what is the criterion adopted by which to judge whether the better lighting is advantageous.

Fortunately the process of letter-sorting is well adapted to an enquiry of this kind. In a works run by a Government Department it is easier to make experiments and record details of output. The process itself is simple and yet involves considerable use of the eyes. The indications of improved efficiency are evident, greater speed in handling material, and greater freedom from errors in sorting; such errors are easily identified. From the records presented by Dr. Ives it is clear that there was a marked increase in the production rate. Thus, in the delivery division average production rates of 14.4, 16.2 and 17.3 lbs. per man per hour were obtained with corresponding illuminations of 3.3, 4.4 and 5.9 foot-candles—i.e., an increase of 12.5 per cent. as a result of the first advance in illumination, and a further increase of 6.8 per cent. when the illumination was advanced from 4.4 to 5.9 foot-candles. Very similar results were obtained in the dispatching department, with an advance of from 3.3 to 7.2 foot-candles.

Of special interest is the attempt to frame a general equation connecting production and intensity of illumination. The formula obtained was naturally derived entirely from data obtained in these particular processes, and the constants in the equation would have to be varied according to the nature of the process, the darkness of material and other local factors. But there is some ground for thinking that most industrial operations could be represented by an equation of the same general form, which appears to reflect the fact that almost all processes consist of distinct parts, one practically independent of the illumination, the other directly controlled by it. (As an extreme instance of a process consisting entirely of the first type, Dr. Ives mentioned the weaving of baskets by blind

workers, whose motions are presumably unaffected by light.) The guiding feature of the relation is the fact that in all cases production at first advances rapidly with increasing illumination, then more slowly, and ultimately approaches a maximum value, presumably characteristic of work under full daylight conditions. The working out of similar relations for other industrial processes might enable us to fix an economical limit to the illumination, which it is desirable to furnish in the interests of efficiency. This would probably depend on the nature of the process; but recent experiments in Germany seem to suggest that it would in general be located somewhere between 10 and 100 foot-candles.

It is much to be desired that the effect of illumination on the speed of other industrial operations should be studied in a similar thorough manner. Such data would enable us to give manufacturers a much better idea of the advantages to be gained by better lighting, and to fix values which it is expedient to attain in practice.

This piece of research work does credit to all concerned, and we hope that similar investigations will be undertaken in this country in order to obtain corroboration of the main conclusions. Facts thus established will go far to secure confidence in the contention, which we uphold, that better lighting is an essential element in increased output and the diminution of industrial fatigue.

## A Course in Illuminating Engineering at the Polytechnic

(Regent Street, London)

AS forecasted in our April issue, the Polytechnic (Regent Street, London) has arranged for a special course in illuminating engineering, extending over two years. The course, like the series of lectures which took place during April and May, will have the co-operation of Mr. L. Gaster, and every effort will be made to include matter of permanent value to students in their subsequent vocations. The course provides for lectures in Light and Optics, Electrical Engineering and Practical Mathematics during the first year. During the second year instruction in the latter two subjects will be continued, and there will also be a special series of lectures on Illuminating Engineering delivered on Wednesday evenings. The course is thus specially adapted for students of electrical engineering who aim at being connected with the lighting side of business, but in any field of engineering the information afforded would be useful. We hope that this enterprising step by the

Polytechnic, which has been a natural consequence of the admitted success of the series of special lectures on illuminating engineering recently delivered, will receive every encouragement, and that this example will be followed by educational institutions in other parts of the country.

At the moment it is evident that instruction in illuminating engineering is best incorporated in courses of a more or less general character fitting students for entrance into the engineering or other professions. But in time to come we believe that illuminating engineering will itself become a recognized profession, for which special courses, following a general education in science and engineering, will be arranged. We have reason to believe that the educational authorities are sympathetically inclined to this idea, and we feel sure that the Illuminating Engineering Society will gladly lend its aid in framing the syllabus for such courses. Another step that should be of great value in facilitating instruction in illuminating engineering is the projected textbook on this subject, to be issued with the co-operation of the Society.

We should also like to take this opportunity of drawing attention to the useful propaganda work of the E.L.M.A. Lighting Service Bureau, which is organizing further series of lectures during the coming season, and inviting the co-operation of the public. Lectures and demonstrations of this kind form a useful supplement to regular courses on illuminating engineering, and there is room for many different forms of educational work in this important field.

## The Standardization of Electric Lamps

THE importance of this subject, to which the writer drew attention in a contribution to *The Times Engineering Supplement* as far back as 1905, is aptly illustrated in a report recently published in the *Journal of the American Institute of Electrical Engineers*, a summary of which appears on pp. 221-222. In the United States the advantages of standardization were early realized. Amongst the most important steps in this direction we may note the adoption of a single form of lamp-socket, initiated about 25 years ago, and the limitation of pressures to three values of 110, 115 and 120 volts, which are stated to be now adopted by 93 per cent. of circuits in that country. It is, however, a matter of common knowledge that considerable progress has also been made in this and other countries within recent years; and that standardization in the lamp industries of the world has already become an international problem.

The progress in this country was illustrated by the new edition of the *British Engineering Standards Association*, issued a few months ago, which deals with both vacuum and gasfilled lamps under the heading of "Normal Type Tungsten Filament Electric Lamps" (No. 161, 1924, superseding No. 133, 1921). The list of authorities represented on this sectional committee responsible for the specification is an imposing one. Great Britain, has had to contend with exceptional difficulties in aiming at standardization. One of the greatest drawbacks under which lampmakers have laboured has been the multiplicity of voltages and systems of supply. This will doubtless be simplified by the movement towards bulk-supply and unification of the present systems. Meantime, it is a satisfactory feature that the Electrical Com-

missioners and supply undertakings are represented on the B.E.S.A. Committee, so that this question can be tackled by joint conference. The standard dimensions adopted for lamp bulbs is a praiseworthy step, and illustrates the desire on the part of lampmakers to bring about uniformity. Even this problem, however, does not rest with them alone, but involves the co-operation of the user. Some large users have, in the past, retarded standardization by insisting on special requirements, which contribute little to efficiency. Here again the B.E.S.A. Sectional Committee meets the need by providing for representation of the chief Government Departments and other large users.

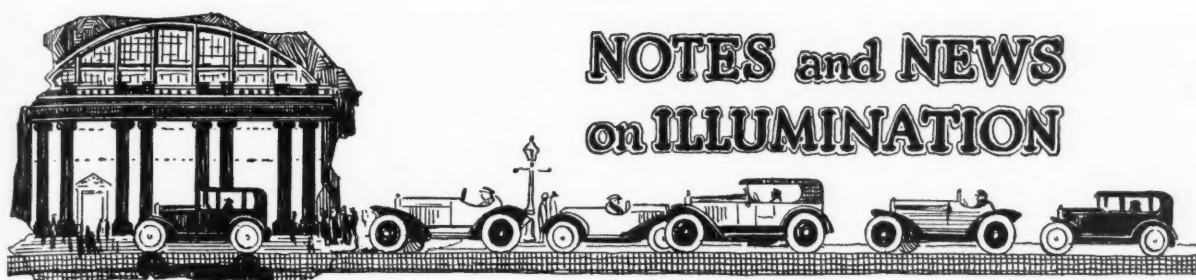
One may feel, therefore, that the position is very much more satisfactory than in the past. Originally there may have been some impression that efforts to frame a standard specification were due mainly to the professors, and were somewhat academic. This, at any rate, is no longer the case. We have now the lampmakers, the supply undertakings, the large users and all concerned working together and evolving a specification which is an actual practical basis for the manufacture of lamps. The value of the work that the B.E.S.A. has done and is doing, both for the lamp-industry and the public, deserves every recognition.

Further advances in this, as in other matters, is largely a matter of education. The public must be brought to understand that by insisting on some peculiar make of lamp they gain no commensurate commercial advantage and present demands that are prejudicial to cheapness and efficiency. Railway and steamship companies similarly, whilst rightly studying their own special requirements in lamps, should avoid so far as possible variations in detail which contribute nothing to quality of the lamps supplied.

Experience has shown the manifest advantages of diminishing to a minimum the variety of types of lamps manufactured. Considering the very much greater range of candle-power available from the gasfilled lamps, as compared with the old carbon filament variety, the number of standard types has been reduced to a moderate figure, and no doubt in course of time will be still further diminished. Standardization in such matters as dimensions of bulbs, distance of centre of filament from base of cap, shape and diameter of filament, etc., is of vital importance to the illuminating engineer; for only in these circumstances can he be sure that the distribution of light characteristic of a certain reflector will be realized in practice. Hence we are glad to note the tendency towards better co-operation between lampmakers and fittings makers in dealing with points of this nature.

From the illuminating engineering standpoint there is, therefore, every reason to welcome the tendency towards standardization that is now proceeding. We must, at the same time, avoid the danger of excessive standardization—the possibility that important advances may be held up owing to the desire not to interfere with existing methods that are working smoothly. Here again the participation of those concerned in the use of lamps in practice, who are naturally anxious to obtain the most efficient lamps and appliances, constitutes a valuable safeguard. It is to be noted, also, that the standard specification is revised at frequent intervals, so that opportunities are provided for taking into consideration new advances.

Illuminating Engineering is in a state of constant development, and it is particularly necessary in this field that specifications and regulations should be reviewed and if necessary modified from time to time.



## NOTES and NEWS on ILLUMINATION

### A Course in Illuminating Engineering at the Polytechnic (Regent Street, London)

It is now announced that, following the series of lectures on illuminating engineering which took place at the Polytechnic earlier this year, a special two years' course has been arranged. The first year will comprise lectures on Light and Optics (Friday), lectures on Electrical Engineering and Laboratory Work (Thursday and Friday), and Practical Mathematics (Thursday). In the second year Electrical Engineering will be dealt with on Tuesdays and Wednesdays and Practical Mathematics on Tuesdays, and there will be a series of lectures on Illuminating Engineering on Wednesday evenings (6-30—7-30). The 1925-6 session opens on Monday, September 28th, and enrolment will be arranged during September 16th-25th, the fee for the session being 30/-. As the lectures take place exclusively in the evening the course will be open to those who are occupied during the day. The course will have the co-operation of Mr. L. Gaster (editor of *The Illuminating Engineer* and Hon. Secretary of the Illuminating Engineering Society).

### The British Engineering Standards Association

At the annual meeting of the British Engineering Standards Association on July 9th the Chairman alluded to the limitation placed on the valuable work of translating British Standard Specifications into foreign languages and disseminating them abroad by lack of funds. A new scheme is to be put into operation in the autumn, however, with a view to enlarging the membership, so as to enlist the active support and participation of all the great industries in the country. The new membership will include professional engineers, industrial firms and business men, who are invited to become members of the B.E.S.A. at a minimum annual subscription of two guineas. Members of technical committees, who give their services without fee or reward, will in future be known as honorary members. The Association has received an encouraging letter from the Prime Minister, and it is earnestly to be hoped that it will in due time gain the additional financial support which its valuable work deserves. This work will doubtless be familiar to many of our readers, to whom the investigations now being carried on by the various sub-committees dealing with photometers, illuminating glassware, street lighting, etc., are of direct interest.

### Institution of Public Lighting Engineers Second Annual Meeting and Conference

The second annual general meeting of the above body is to be held in Leeds this year. The meeting will be held in the Philosophical Hall during September 14th-16th, the chair being taken by the President (Mr. S. B. Langlands). Addresses will be delivered by the President-elect (Mr. C. S. Shapley, of Leeds) and Councillor E. J. Clarke, Chairman of the Leeds Street Lighting Committee. Papers on "Electric Lighting in Rural Areas" and "Street Lighting by Gas" are also announced. Members and delegates will be received by the Lord Mayor and Lady Mayoress, and opportunities will be provided for examining the lighting of the city.

### An Antique Lighting Unit

Under this heading a writer in *Electricity* mentions his recent experience when examining an old bedroom lighting unit more than 200 years old and, it is understood, the only one of its kind in existence. This device is the property of an old Leicestershire family. The unit is made of earthenware and is glazed in white; it is hand-painted, the design being in blue, green, pink, yellow and red. It is totally enclosed except for two apertures on the top; one of these contains a pith "wick" and the other is obviously for the purpose of conducting oil to the interior of the container; a small handle completes the unit. As a direct lighting unit the wick is turned towards the user; for indirect lighting the unit is turned halfway round. Here the oil entrance, which is fitted with a kind of a boss, completely covers the aperture on the under side of the handle. This arrangement effectively cuts off the direct light and reflects the "raw" light on to the walls and ceiling, from which it is reflected and diffused throughout the bedroom. The decorative features of this unit are outstanding in their beauty; this goes to prove that the modern tendency for decorative lighting units is inherited from our ancestors, also that the idea of "indirect lighting" is not, as is sometimes supposed, an exclusively modern one.

### Colour in Concrete

An informative article by Mr. W. G. Raffé in *Kahcrete Engineering* points out the possibilities of colour-treatment in connection with concrete structures. Concrete buildings may be coloured in the Roman fashion by decorative additions, such as marble or stone plating, or by adding mosaic. But these relatively expensive methods are hardly adapted for extensive use on small buildings. There are, however, other direct methods of adding suitable colouring material to the concrete. Colouring elements may be added to cement in the aggregate or suitable coloured chippings may be included, the surface being afterwards scrubbed, producing a pleasing texture.

At a little distance dots of pure colour are merged by the eye giving a combination effect, which may be likened to that of coloured inks on paper. It is commonly assumed that coloured surfaces for buildings are not adapted to grey Northern latitudes. But there is no inherent reason why they should not be employed, giving a brighter effect in our streets, provided inexpensive and convenient methods can be devised. Incidentally the general use of colour would render flood-lighting distinctly more interesting.

### The Kinema as a "Universal Socializer"

The effect of the kinema in bringing people in different parts of the world in contact was somewhat strikingly illustrated by a film recently produced by the International General Electric Co. This film was made in Cuba, and represented a pictorial story of some of Cuba's electrical sugar mills. Soon after completion the film was shown to an audience in the Philippine town of Lingayen and witnessed by the greater part of the local population. Later the same film was shown at the Chinese Y.M.C.A. at Manila, at a motion picture theatre in G Benguet, at the Pampanga sugar mills in Java, and at Singapore. Each time the film was shown to an audience of eager folk, all concerned in the sugar industry and much interested to see how sugar was produced in different parts of the world.

## The Nature of Eyestrain

*The British Journal of Ophthalmology* remarks that the gradual adaptation of the human eye, as civilization progressed, to the accurate close work demanded by that process is doubtless a factor in "eyestrain." But this adaptation has become so perfect in the course of time that it may be doubted whether eyestrain can be the primary cause of indigestion, migraine, and other ailments as is sometimes supposed. Our eyes are given us to use, and with a healthy body and a healthy mind the eye should be capable of doing its work without pain, just as other healthy organs do. The effects of eyestrain at the present time are obvious in many cases; the rush and hurry of modern life have much to do with it. But, it is suggested, we may often be in error in concentrating all our attention on the eyes and errors of refraction, without paying due attention to the general health.

The writer, in expressing this view, draws attention to the amount of work done by the eyes of men and women of long ago, before the use of spectacles was general. Samuel Johnson accomplished a prodigious amount of work with his eyes, and apparently had only one useful eye on which to rely. It may be conjectured that his irritability and indigestion were due to eyestrain—but it may be doubted!

Attention is also drawn to the samplers worked by the eighteenth-century female, the fine lace work done by hand, and the work of the manuscript writer and the illuminator of missals. "Those who have had experience in reading the ancient records will agree that the study of some of the handwriting of the early clerks is as trying to the eyes as any form of ocular work; how trying it must have been to the clerk of the thirteenth century who engrossed a charter or a final concord on a slip of parchment, every letter usually perfectly formed and with the contraction marks which mean so much, it is difficult for anyone to imagine who is unacquainted with this style of work."

If the fact that such fine work was habitually done at a time when spectacles and similar aids to vision were unknown is surprising, it is equally remarkable that it should have been done in an age when methods of artificial illumination were so primitive. Unluckily, we have almost no records of the sight of clerks during the past ages. But we recognize to-day that to attempt continuous fine work without adequate illumination is to invite eyestrain and physical fatigue, and it may be conjectured that such fine work was done almost entirely in daylight, and only rarely by the feeble illuminants of the past.

## Obituaries

PROFESSOR ANDRÉ BROCA.

PROFESSOR ANDRÉ BROCA, whose recent death will be widely regretted, was a man of varied attainments and most versatile knowledge. Originally entering the *Ecole d'artillerie* at Fontainebleau in 1885, he soon diverted his attentions to experimental work, becoming eminent alike in physical and medical research. He was not only President of the *Société française des Electriciens* but also a member of the *Académie de Médecine* and professor of medical physics at the *Faculté de Médecine* in Paris. He was responsible for many varied researches in both fields of knowledge. He contributed greatly to advances in the technique of

X-ray tubes, was responsible for much optical and acoustic research during the war, and was awarded a prize in 1916 for his apparatus for detecting the presence of submarines.

It was, however, for his work on photometry and the effect of light on the eye that his name was best known to illuminating engineers. He became a corresponding member of the Illuminating Engineering Society early in its existence, and showed a most lively interest in the development of good lighting on the hygienic side. In particular, he devoted attention to the recognition of glare, which he studied by means of observations on the duration of the retinal image. The writer can recall meeting him at the International Congress on Industrial Hygiene in Brussels in 1910, when he contributed a paper dealing with industrial lighting, and at other subsequent international congresses he frequently presented communications dealing with various aspects of illumination and photometry. Professor Broca was amongst those who have contributed very greatly to advances in knowledge of illuminating engineering on the ophthalmological side in France, but his work was of international reputation, and by his death illuminating engineering throughout the world has suffered a great loss.

PROFESSOR DR. OTTO LUMMER.

Born July 17th, 1860.

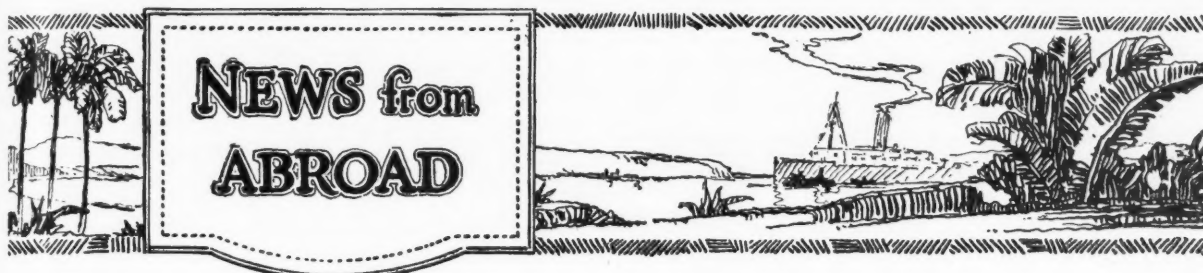
Died July 5th, 1925.

WE learn with great regret of the death of Professor Dr. Otto Lummer, which occurred on July 5th. In this country Dr. Lummer's name was rendered familiar by its association with the "Lummer-Brodhun" photometer, which still finds a place in every well-equipped photometric laboratory, and was a striking instance of the application of scientific principles in instrument design. His chief work, however, was done at the *Physikalisch-Technische Reichsanstalt*, in Charlottenburg, which he entered when it was founded in 1887. Under his patient supervision much valuable experimental work on standards of light was done. Besides studying in detail the various factors affecting the constancy of the Hefner standard he occupied himself with the examination of radiation from a black body, and was amongst the earliest to propose this as a basis for an absolute standard of light. From 1905 onwards he was Professor of Physics at the Breslau University, where much of his research work was carried out.

Professor Lummer was also one of the originators of the German Illuminating Engineering Society. At the first meeting of the Society, in 1913, Dr. Lummer read a paper on "Auge und Lichttechnik." When it was decided to form this Society the British Illuminating Engineering Society was invited by the *Reichsanstalt* to send full details of its constitution and method of working as a guide to the organization of a similar body in Germany. The writer, who was on a visit to Berlin at that time, was able to meet various experts interested in this matter, and to give the desired information. Professor Lummer took a keen interest in the Illuminating Engineering Society in this country, of which he was a vice-president and corresponding member.

Whilst primarily a physicist, he took a great interest in the physiological basis of vision, which he applied to explain many phenomena in connection with heterochromatic photometry. This knowledge of the physical and physiological side was again illustrated in his book on "Die Ziele der Leuchttechnik," which attracted much attention.

Dr. Lummer was an extremely accurate and painstaking experimenter, and it was due in a large measure to him that the photometric department at the *Reichsanstalt* attained such a well-deserved reputation.



### Comité français de l'Eclairage et du Chauffage Work on Illuminating Engineering

At the last meeting of the above body, which forms the National Illumination Committee in France, several useful communications were presented. M. Bossu, President of the Commission des projecteurs d'Automobiles, dealt with the specification of candle-power of headlights in accordance with the requirements of the Commission, and it was decided that the conditions should be set out in a special statement to be furnished to the two official laboratories undertaking the checking of all headlights. The two official testing laboratories are the Laboratoire Central d'Electricité for electric headlights and the Laboratoire du Conservatoire des Arts et Métiers for other forms. M. Jouast and M. Cellerier, representing these two laboratories, gave an account of the procedure on which the granting of official certificates is to be based. It was also mentioned that the Committee dealing with the lighting of schools and factories, in co-operation with a committee of the Société française des Electriciens, has, at the request of the Ministère du Travail, been considering the revision of the requirements specified in 1913. Its conclusions will be communicated to the Ministère du Travail in due course. There was also a note by M. Abraham on a proposed absolute standard of light, based on the light yielded by a "black body." This investigation has been undertaken, under his supervision, by Mons. P. Fleury, and was regarded as of great scientific importance. It was agreed that a contribution should be made to the cost of researches with the object of bringing this device to a practical stage, to be undertaken by MM. F. Rouland and H. Laurain. It is estimated that the total expenditure necessary will be 150,000 francs.

### International Congress of the Technical and Trade Press

An important international conference of trade and technical papers is to be held in Paris during October 1st-4th. The Congress will be under the auspices of the French Association of the Technical Press, and will cover the following main divisions: (1) Definition and status of trade periodical reviews, (2) the aims of trade periodical publications, (3) the development of the trade Press, (4) legal phases of trade paper publication, (5) advertising, (6) transport and distribution, (7) methods of establishing publicity agencies abroad, (8) an international review of the technical, industrial and commercial Press, (9) the constitution of an International Federation of the Technical and Trade Press, (10) organization and co-ordination of international documents, (11) should the trade Press become affiliated with the Society of International Co-operation of the League of Nations? (12) should the development of Esperanto as an international language be encouraged? (13) modern methods of printing and publication, (14) the creation of technical, industrial, commercial and economic libraries in the various capitals and larger cities.

Under these headings many questions of considerable importance to the trade and technical Press will be discussed, and it is to be hoped that this country will be adequately represented. Full particulars may be obtained from M. Mounier, 8 Rue de Miromesnil, Paris.

### The Great Earthquake of 1923 in Japan

A paper presented by Mr. M. Shibusawa (President of the Japanese Electrotechnical Committee) at the International Conference on Transmission Systems recently held in Paris, gave a graphic account of the great earthquake that almost demolished Yokohama and a great part of Tokyo in 1923. Mr. Shibusawa summarizes the results of work of a committee which has been engaged in studying the damage to electric plant and installations, and formulating precautionary measures for the future. Some important stations in the earthquake area were almost demolished, others escaped with little damage. Overhead transmission lines were much interrupted. Apart from the devastating fires most of the damage to plant was due to collapse of buildings. The fact that almost normal supply was available about four months after the earthquake is a great tribute to the recuperative energy of the Japanese engineers. As a result of a very careful enquiry it is believed that few, if any, of the 80 different fires following the earthquake were of electrical origin, as by far the greater part of the supply was cut off immediately the earthquake began. This safety precaution will be adopted in future emergencies. Reference is made to the recognition of the urgent necessity of restoring *first* public lighting and *next* interior lighting as soon as possible after the cessation of shocks, in order to allay panic. But it is vital that all damaged circuits should be isolated and the public must be warned of the grave dangers attending the use of electricity during the restoration period in houses liable to collapse. It is considered that the existing Government wiring regulations, if scrupulously followed, require no modification. Various precautions, such as the provision of alternative transmission lines and communication circuits, are also suggested.

### Transactions of the Japanese Illuminating Engineering Society

The last issue of the Transactions of the Japanese Illuminating Engineering Society that have reached us suggests that the Society is making good progress, and is being kept conversant with developments in Europe. A new feature is the series of abstracts of American and European papers dealing with illumination, and quite a comprehensive bibliography. Contributions deal with street lighting in Tokyo, an "Electric Home" at Chofu, and a new method of manufacturing large parabolic mirrors. We are glad to see that Japan is being kept in touch with progress in Europe, but, as previously suggested, we wish that our friends in Japan could do something to render their own work more accessible to us. The contents of the Transactions are still printed in Japanese characters, and it would be a welcome and valuable addition if in future abstracts of the more important papers in the Transactions could be printed in English.

### Report of Lighting Educational Committee

The Lighting Educational Committee (U.S.A.), of which Mr. J. E. Davidson (the new President of the N.E.L.A.) is Chairman, has recently published a report of its work. This deals largely with the "Better Home Lighting" contest amongst school children. Methods of approaching the public and general organization are discussed in detail. Excellent results are said to have attended the measures to secure co-operation on the part of educational authorities in the scheme.

## The Distribution of Scientists

We notice in the Journal of the Franklin Institute a reference to an interesting publication, suspended during the war but now again printed in Belgium (*Isis*). The editor has been studying the distribution through the centuries, of men of science. Up to the end of the thirteenth century 1,248 scientists of note are recorded, distributed into four main groups according to the language used. A curve presents the number of scientists in the East and West respectively, from 900 B.C. to 1300 A.D. From 650 A.D. the West was the most productive, for the next 500 years the hegemony of science returned to the Eastern world, but after 1150 A.D. the East increased its output but little and the West showed vastly greater activity. Apparently Greek influence was paramount during down to the sixth century, then for one century the Hindu and Chinese, and from the eighth to the eleventh century, and to an astonishing extent, the Moslem. This, it is remarked, makes it clear why knowledge of Arabic is as essential for understanding mediæval thought as a knowledge of Latin and Greek. But ever since the eleventh century Western Christendom has been the great leader.

## Regulations for Portable Lamps in Germany

In view of the discussion that has been proceeding regarding the I.E.E. wiring rules in this country, it is interesting to note that in Germany the Verband Deutscher Elektrotechniker is proposing that all portable lamps should be subject to a test, and marked with an indication that they are considered satisfactory, before issue to the public. It is pointed out that very large numbers of such lamps are issued, and that poor workmanship and wiring in many cases constitute a danger, and bring electric lighting into disrepute. Moreover, the public does not discriminate between portable lamps of sound construction and cheaper but inferior varieties. From recent communications to *Licht und Lampe* it appears that some makers view such a proviso with concern and consider it unworkable. But for the V.D.E. it is contended that tests could readily be conducted at approved centres, and that in the long run such supervision will be for the benefit both of the public and the industry.

## Developments in Acetylene Lighting

*The Journal de l'Acetylene*, in reviewing progress in acetylene lighting, draws attention to a change in the methods of using acetylene for lighting purposes. It is estimated that in France the consumption of carbide is approximately 20,000 tons per annum. This figure is not very noticeably less than in the days before the war, when the highest consumption scarcely attained 25,000 tons. What has changed, however, is the proportion of carbide used for permanent lighting installations. In pre-war days about three-quarters of the annual consumption of 25,000 tons was devoted to this field, whereas of the present 20,000 tons probably not more than a quarter is used for permanent installations. It is estimated that one-half is now used for portable lamps of all kinds, automobile headlights, projectors, signal lamps and other lighting specialities. There remains, therefore, about a quarter devoted to welding, etc. This, it is remarked, is an interesting result, seeing that in most other countries not more than one-tenth of the carbide used is supplied for lighting. It illustrates the firm hold that acetylene lighting has secured in France. Although the activities of the *Office Central de l'Acetylene* have been frequently devoted, during recent years, to automatic welding, lighting has also been the subject of constant attention, and has by no means been

neglected. As regards the future it is possible that the number of permanent acetylene lighting installations may remain stationary or even decline. But on the other hand the use of portable acetylene lamps, and the diverse lighting specialities referred to above, should continually be developed. One sees here a situation something like that in the gas industry. Just as some gas companies have been, in the past, concentrating their attention on heating with gas, so some acetylene concerns have been almost exclusively occupied with acetylene welding. In either case there is a danger that in the development of the new field the original lighting business may be let slip. On the other hand, when the value of the lighting business is appreciated and efforts are made to foster it, progress in this field is still recorded, though it may develop more quickly in some directions than others.

## Model Show-Window Lighting

We notice that the Rheinisch-Westfälische Elektrizitätswerk has recently adopted the expedient at Essen of constructing a special show-window on an important site in the town, to serve as a model of attractive lighting. The contents of the window are rendered as striking as possible, and different methods of lighting are automatically exhibited. As a means of propaganda the experiment is said to have been a great success, and large numbers of people gathered to witness the changing conditions of illumination. Apart from its general educational value it is believed that the exhibit will have a material influence in inducing shopkeepers in the neighbourhood to adopt better methods of lighting. The same plan is to be followed in other towns in the Rhineland. Demonstrations of this kind involve considerable care. Apart from the pains taken in obtaining an attractive display of goods, and in designing the special lighting, there is the fact that in many of these towns streets are narrow and the assembly of crowds is apt to be inconvenient. Hence it is necessary to select a site where there is sufficient freedom for people to collect and view the window.

## A Customer's Tribute to Good Lighting

*The Electrical World* records an incident that is less frequent than it should be—a consumer's voluntary testimony to the value of better lighting. The main floor of the Dayton Company's Department Store in Minneapolis was recently relighted by methods specified by the Northern States Power Company. The Company did not foresee how much pride the owners of the new installation would take in the improved appearance of their store. It was, therefore, a pleasant surprise when the customer unexpectedly, and without solicitation, inserted the following advertisement in a local paper:—

### LIGHT.

Each bright street, cheery window, sunny home or factory, and illuminated office or shop adds to the total of human happiness and contentment and optimism.

Light ranks below only food and water and air in its contribution to human comfort and progress.

Compare the bright, mellow, shadowless light of Dayton's new main floor with any less scientific and less generous use of illumination, and you will realize that you lift your head, step more briskly, and feel more vigorous when you step into the store.

The new lighting shows our goods to better advantage, too. It may make you want to come to Dayton's and to stay all day, we hope.

But it is one of those appointments of a store that is of real value to the community, in addition to its commercial value, because of the cheer it spreads and the vitality it breeds.

THE DAYTON COMPANY.

## TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

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### Study of the Effect of Degree of Illumination on Working Speed of Letter Separators in a Post Office\*

By JAMES E. IVES, Physicist, Office of Industrial Hygiene and Sanitation, United States Public Health Service

IN connection with the studies made by the United States Public Health Service relative to the protection and care of the eyes of industrial workers, the question has frequently arisen as to the degree of illumination that is necessary in order that work of a certain character involving the eyesight may be performed with the least strain on the eyes. It is to be assumed that, other things being equal, the degree of illumination best for the eyes is that under which the work in question can be performed with the greatest ease. The most natural measure of the ease with which work can be performed is the speed of working, or, in other words, the rate of production. It therefore becomes important, from the standpoint of the protection and care of the eyes, to determine in what manner the rate of production in industry depends upon the degree of illumination under which work is performed.

The study discussed in this report was made during the year 1923 in the New York City Hall Post Office. In a recent survey of the illumination of the New York post offices, which was made by the Office of Industrial Hygiene and Sanitation, United States Public Health Service, as described in Public Health Bulletin No. 140, it was found that there was a marked increase in the number of test cards sorted per minute when the illumination was increased from 3.6 to 8 foot-candles. Since the tests in this survey were made with specially prepared cards, it was thought desirable to find out whether the same increase would occur when the clerks handled the ordinary letter mail, and whether this increase would be maintained if the increased illumination were maintained.

The study was carried on jointly by the Post Office Department, the Supervising Architect's Office of the Treasury Department, and the Office of Industrial Hygiene and Sanitation of the United States Public Health Service.

It was decided to make the study by weighing the total letter mail sorted by a group of eight clerks at certain separation cases, every half-hour, from 1 p.m. to 4 p.m., and by another group of eight clerks, from 4 p.m. to 9 p.m., for four consecutive days under a given illumination; also to make tests simultaneously in the dispatching division on the mezzanine floor of the post office, and in the delivery division on the first floor. The tests on each floor were made at the same set of letter cases.

The sorting process carried on in the dispatching division is a primary one, involving 34 separations; that carried on in the delivery division a secondary one, involving 50 separations.

Six series of tests were made, in January, February, June, September, November and December respectively.

As the study proceeded it was not found possible to give four consecutive days to each series, so that each of the three later series of tests covered only three days; it was not always possible to use the same clerks on the successive days of the same test. But a record was kept for each half-hour period of the number of clerks working during that period, and the total time spent in work by the group was recorded.

The clerks worked in three shifts of eight hours each, and the test for each group was made during the first part of the shift, except for the group on the first floor, working from 1 to 4 p.m., for which the test was made during the latter part of the shift.

The tests were made almost entirely under artificial light, there being very little natural light at the places where they were carried on. In the four later series of tests, readings of the illumination were taken on each side of each aisle, throughout its length, both directly under and between the units. The average of these readings was taken as the illumination under which the test was made, and in the later tests the deviation at any point was seldom greater than 20 per cent. of the average value.

#### RESULTS OF THE STUDY.

The first tests were made from January 16th to 19th, under the lighting installations which had been in use for some time, and which gave an illumination on each floor of about 3.3 foot-candles.

After these tests had been made, 16-inch Trojan units, made of opal glass and totally enclosed, were installed in the aisles, with 200-watt Mazda C lamps on the mezzanine floor, and 150-watt Mazda C lamps on the first floor, giving an illumination of 7.7 foot-candles on the mezzanine floor, and of about 4.3 foot-candles on the first floor. On the mezzanine floor the Trojan units were hung in two rows in the aisle, with the units in each row 10 feet apart, the bottom of each unit 10 feet above the floor, and its centre 1 foot in front of the letter separation case. On the first floor the Trojan units were suspended from the existing outlets, in two rows in the aisle, the outlets in each row being about 11 feet apart. After the clerks had worked under these installations for about a month, the second series of tests was made on each floor from February 13th to 16th. The clerks then continued to work under these installations until the third series of tests was made from June 11th to 14th.

On July 25th the illuminations under these installations were again measured and were found to give 7.5 foot-candles on the mezzanine floor and 4.3 foot-candles on the first floor. The lamps were then reduced to 150 watts on the mezzanine floor and 100 watts on the first

\* Abstract of a reprint from the Public Health Reports, Vol. 39, No. 46, Nov. 14th, 1924, pp. 2825-2851.

See *The Illuminating Engineer*, April, 1925, pp. 98-99.

floor, the illumination on the two floors falling to 6 and 3.5 foot-candles respectively. It was not possible, however, to make tests under these new intensities of illumination, since, shortly after this date, the post office was repainted, the ceilings and the upper part of the walls being done in white and the lower part of the walls in black or dark grey. Measurements of the illumination on September 15th showed that the repainting had had the effect of raising the illumination under the 150 and 100 watt lamps to approximately what it was formerly under the 200 and 150 watt lamps, namely, to 7.2 foot-candles on the mezzanine floor and 4.6 foot-candles on the first floor. The fourth series of tests was made under these installations from September 10th to 12th.

The clerks continued to work under these installations until November 12th, when the fifth series of tests was begun. Measurements of the illumination showed that it had apparently deteriorated to 6.5 foot-candles on the mezzanine floor and to 4.3 foot-candles on the first floor.

The wattage of the lamps was then lowered to 100 watts on the mezzanine floor and raised to 150 watts on the first floor, giving an illumination of 3.8 foot-candles on the mezzanine floor and 5.9 foot-candles on the first floor. The clerks then worked under these installations until December 10th, when the sixth and last series of tests was begun.

The results of all the tests show that the rate of production ranged from 30.1 to 34.2 pounds per man per hour in the dispatching division, and from 14.4 to 17.3 pounds per man per hour in the delivery division. The average rate of production in the delivery division was, therefore, only about half that in the dispatching division.

The difference in the production rate for the two divisions is evidently to be ascribed to the fact that it takes longer to handle each individual letter in the delivery division, with 50 separations, than in the dispatching division, with 34 separations.

The results seem to show that after a higher illumination had been installed the production rate had a tendency to increase during the course of from two to four months, even though there was a slight decrease of illumination due to deterioration of the lamps and to other causes.

It was originally intended (1) to find the rate of production under the old illumination; (2) to increase the illumination so as to find the change in the rate of production; (3) to maintain the illumination constant for a while in order to determine whether there was any change in the rate of production—either an increase or a decrease—with the lapse of time; (4) to decrease the illumination; and (5) still further to increase it or decrease it; giving tests under four different intensities of illumination in each division. But, as already explained, the repainting of the post office had the effect of reducing the number of illuminations used practically to three, since, in both divisions, the illuminations in the February, June, September and November tests were, on account of the repainting, approximately the same. If we take the mean production rate and the mean illumination for these four months in the dispatching division we get a mean production rate of 33.7 pounds per man per hour for a mean illumination of 7.2 foot-candles; and, in the delivery division, of 16.2 pounds per man per hour for 4.4 foot-candles. The results in the dispatching division give, in the order of time in which they were obtained, average production rates of 30.1, 33.7, and 32.1 pounds per man per hour for corresponding illuminations of 3.3, 7.2, and 3.8 foot-candles, or an increase of 12 per cent. in the production rate in going from 3.3 to 7.2 foot-candles, and a decrease of 4.7 per cent. in going from 7.2 to 3.8 foot-candles. In the delivery division we obtain average production rates of 14.4, 16.2, and 17.3 pounds per man per hour for corresponding illuminations of 3.3, 4.4, and 5.9 foot-candles, or an increase in the production rate of 12.5 per cent. in going from 3.3 to 4.4 foot-candles, and a further increase of 6.8 per cent. in going from 4.4 to 5.9 foot-candles.

The results of the last two tests on each floor are very marked. A test was made from November 12th to 14th under 150-watt lamps in the dispatching division, and under 100-watt lamps in the delivery division. After this test had been made, the wattage was reversed, 100-watt lamps being installed in the dispatching division and 150-watt lamps in the delivery division. The illuminations were correspondingly decreased from 6.5 to 3.8 foot-candles in the dispatching division and increased from 4.3 to 5.9 foot-candles in the delivery division. Four weeks later another test was made. In both divisions a marked change in the production rate was obtained, in the former division a decrease, and in the latter an increase.

An increase in the rate of production with improved illumination in the case of these experiments is unmistakable, and is not due to chance. For instance, from January to February there was, for the work involving 34 separations, an increase of 3.5 pounds on the average in the rate of production, whereas the probable error of this difference was but 0.91. Similarly for the 50 separations, the increase of one pound was much greater than its probable error, namely, 0.33.

#### PROPOSED THEORY FOR THE RELATION OF PRODUCTION TO ILLUMINATION.

In an attempt to find a relation between the rate of production and the illumination under which the work was performed results of tests were plotted against the illuminations used. Various factors can be adduced to explain why some points did not lie on the smooth curves drawn, such as the fact that workers in successive tests were not always the same, and an apparent lag between changes in illumination and changes in production. Evidence of such a "lag" has already been noted in the previous inquiry into lighting conditions in post-offices, and likewise in some investigations in England on the relation of illumination to coal production.\* This lag appears to be either positive or negative according as the illumination is decreased or increased; the production rate only rising or falling to the ultimate value corresponding to a given illumination after the new conditions have been maintained for some time.

An inspection of the curves suggests that they are not logarithmic, parabolas or hyperbolas, since when illumination is zero production must also be zero. The shape is believed to be fairly correctly represented by the equation:—

$$P = P_e (1 - e^{-kI}),$$

where  $P$  is value of production rate in pounds per man per hour,  $P_e$  a constant value which the production rate approaches when the illumination increases;  $e$ , the base of the natural system of logarithms (2.718);  $k$ , a constant determining the slope of the curve; and  $I$  the illumination in foot-candles.

From a study of the curves and this derived equation it is deduced that if glare is avoided the production rate will increase with the increase in illumination—increasing at first very rapidly and then slowly, and approaching at an intensity somewhere between 10 and 100 foot-candles, a value which for all practical purposes may be assumed to be constant; this constant value being the production rate under good daylight illumination, after which it will remain practically constant. But if the increased illumination is accompanied by the deterrent effect of glare, a value will be reached such that the production rate, instead of increasing, begins to decrease.

By suitably choosing  $P_e$  and  $k$ , calculated values of  $P$  may be obtained which agree very closely with those obtained from curves. As an example, in one case it was found necessary to take  $P_e = 33.9$  and  $k = 0.69$ , whilst in another curve  $P_e$  was found equal to 18.6 and  $k = 0.46$ . In examining results it was found, for curve (1), that in going from 3.3 to 7.7 foot-candles an increase in production rate of 10.5 per cent. was obtained;

\* Farmer, Adams and Stephenson: An Investigation in a Coal Mine. (*Journal of the National Institute of Industrial Psychology*, Vol. 1. pp. 173-181, 1923.)

similarly for curve (2), in going from 3.3 to 5.9 foot-candles, an increase in the production rate was 18.5 per cent. Several considerations show that even if this equation does not *exactly* represent the relation between illumination and production, it must be of this general character. The production rate is equal to the average weight in pounds of a single letter, divided by the time,  $T$ , occupied in handling it.  $T$  is made up of three parts, namely, the time occupied in reading the address and in deciding what pigeon-hole to put the letter into, and the average time taken by the operator to move his hand to the pigeon-hole and back again. Illumination will probably have a much greater effect on the first part of the time than on the second or third part. All processes of production involve manual labour to some degree, and may in general be divided into two parts, one dependent on the use of the eyes, and the other independent of them and not involving illumination. (In the case of blind people making brooms or caning chairs the whole process is of the latter character.)

This consideration helps to explain the form of the curve. The constant  $k$  has an interesting physical meaning. In electromagnetism and mechanics the reciprocal of  $k$  is the "time-constant" and equal to the time it takes for the quantity under consideration to reach 0.632 of its steady value. Similarly in the present case the reciprocal of  $k$ , which we may call the illumination-constant, affords a measure of the illumination at which approximately two-thirds of the final full production is obtained. Thus, with  $k=1$ , the production for all practical purposes has reached its greatest value at 8 foot-candles; with  $k=0.6$  at 8 foot-candles it is 1 per cent. below it; with  $k=0.4$ , 4 per cent. below it, and so on.

It has long been recognized that some kinds of work require more illumination than others; higher illuminations have accordingly been specified for particularly fine work, and when the reflection factor of the material worked upon is low. Such factors would naturally affect the constants in this equation. Such information as exists seems to indicate that the formula will at least approximately represent the relation between illumination and production rate. Results obtained on the sorting of letter-cards by different illuminations of 3.6, 8 and 14 foot-candles respectively can be calculated to within  $\frac{1}{2}$  per cent. if  $P$  is taken as 60.3 cards per minute and  $k$  as 0.77.

Other available records yield some support to this suggestion. Data obtained by Hess and Harrison for the inspection of roller bearings at illuminations from 5 to 20 foot-candles, if not showing conclusively that the production rate approaches a constant value as illumination is increased, at least do not disprove such an assumption. Data obtained by Cohn, Ferree and Rand, Luckeish Taylor and Lowden, and Cobb, in investigations on visual acuity, speed of discrimination, speed of reading and speed of vision, are interesting in this connection. Cobb, for instance, found that, with a very simple process speed of vision apparently increased as the logarithm of the brightness of the field; but when a larger and more complicated test object was used, a maximum speed of vision was attained for a brightness somewhere below 100 millilamberts, further addition to the illumination adding nothing to the speed. It is to be noted that for moderate values of  $k$  (for example, in the neighbourhood of 0.4) the curve derived from the author's experiments coincides closely with a logarithmic one; beyond  $k=4$ , however, the curves diverge. It seems to be indicated by the researches of Cobb and others that, for a simple stimulus, speed of vision varies directly as the logarithm of the brightness of the test object. But if the stimulus is a complicated one, the relation between speed of vision and illumination is no longer logarithmic, but approaches the form indicated by the author's equation. In practice, moreover, the relation between illumination and production rate is complicated by the time occupied by manual and mental processes, both being, in a greater or lesser degree, independent of the illumination. It seems possible, therefore, that in general the relation between illumination and production rate will be given by an equation of the form suggested in this paper.

## Records of Daylight with the Photo-Electric Cell

IN a recent contribution to the *Transactions of the Illuminating Engineering Society* (U.S.A.), Dr. James E. Ives gives an account of some experiences with the Case photo-electric cell, which the United States Public Health Service has been experimenting with for daylight illumination measurements. In such work the most important factor is the relation between the external illumination and the actual illumination within a building, but the fluctuation in the intensity of daylight often makes simultaneous measurements difficult. In studying daylight it is often desirable to make tests over a considerable period; hence some method of automatic physical measurement would be extremely convenient and valuable, if trustworthy.

The Case photometric cell, used in these experiments, has promising features. It is made of hard glass in the form of a cylindrical bulb. The negative electrode consists of a film of aluminium, deposited on the inner surface of the bulb and also on a rectangular plate. The positive consists of a loop of platinum ribbon coated with an oxide of barium reduced by heat, leaving a fine film of active material. When a voltage is applied and the cell is exposed to daylight a photo-electric current flows. Case has found that if the voltage is not less than 200 the current is practically proportional to the illumination received by the cell; also that sensibility remains constant over at least three to four years, and that the effect of temperature is negligible. The sensibility has a maximum in the blue-violet, but by using a filter of brownish yellow glass a curve closely resembling that of the human eye can be produced.

Such a cell should, therefore, prove valuable for records of daylight. In the form used by Dr. Ives it is equipped with an automatic recorder so that variations in daylight are traced on rolls of paper. These appear to follow the fluctuations in daylight-intensity quite closely, and the influence of darkness during a thunderstorm is clearly shown.

There are, however, several precautions which are found necessary, and also several points in connection with the operation of the instrument that need elucidation. The voltage (supplied by a series of radio dry cells) must not fall below 200. The bulb, if mounted outside in an exposed position, must be kept clean. Two questions regarding the behaviour of the cell need further study. The first, and the most important of these, is the question whether the ordinates on the paper chart are strictly proportional to the illumination. Case believes that this is so. But Dr. Ives mentions that, according to some tests made with a Macbeth Illuminometer, a scale reading corresponded to about 200 foot-candles at noon and about 270 foot-candles at 5 p.m. on the same day. This might be due to a change in the quality of daylight. (The instrument records all light received, whether direct sunlight or light from white clouds or blue sky, and this is one manifest advantage in taking measurements at times when a uniformly bright sky is not available.) But it may also be connected with the fact that colour filters were used with the Macbeth instrument.

The second question is whether the instrument truly measures illumination in an horizontal plane. The construction of the cell is such that we have not to deal with a simple horizontal plane surface, and Case has sought to rectify this by using a special shield. It remains to be seen, however, whether this is successful in obtaining adherence to the cosine law; the point is of consequence when we are dealing with skies of uneven brightness or with direct light from the sun at a low altitude.

## Some Notes on Public Lighting by Electricity in Paris

A SURVEY of methods of electric lighting in the streets of Paris was given by Mr. J. Mariage (Chief Engineer for Public Lighting of the Compagnie Parisienne de Distribution d'Electricité), in a recent issue of *The Revue Generale de l'Electricité*, to whose courtesy we are indebted for the illustrations accompanying this note.

In the early part of the article it is recalled that public lighting was developed in Paris in a permanent form almost as soon as Lebon's discovery of gas became known. This method continued as the sole method of lighting until the introduction of electric lighting, originally with arc lamps, but recently by the aid of gasfilled incandescent lamps in considerable numbers. At the present time there are 2,327 lighting units using arc lamps and 2,293 using gasfilled incandescent lamps. The height of suspension in general varies from 6.2 to 7.5 metres, requiring respectively 1,052 and 1,738 kW., a total of 2,790 kW. The programme for 1925 includes the addition of about 670 additional lamps, distributed over 30 km. of road.

The Bardon enclosed arcs replaced the ordinary arc lamps in 1913, and up till 1920 public lighting by electricity was done exclusively by lamps of this type. Lamps taking 10, 12 and 15 amps. yield respectively maximum candle-powers of 1,760, 2,265 and 3,220 with continuous current, and 1,251, 1,522 and 1,850 with alternating current. In the former case, with lamps burning nine in series, a specific consumption as low as 0.216 watts per candle may be obtained; but with alternating current values from 0.315 to 0.344 watts per candle are found. In the original article polar curves of light distribution of these lamps are presented, and the method of control is described in some detail. The city of Paris pays for public lighting on the basis of so much per lamp-hour in some areas and per lamp-day in others.

The introduction of gasfilled electric lamps has been attended by convenience in several respects, notably in the fact that subdivision of the lighting units, by arranging several lamps in one lantern, is possible. Fig. 1, for example, shows a typical lighting unit of this type. In each lighting unit three conductors are introduced, one supplying a lamp for all-night burning, another two additional lamps which burn only up to midnight, and the third serving as a common return. Current is distributed at 220 volts (two-wire system), lamps thus receiving 110 volts each. The position of the filament with respect to the reflector can be adjusted. Polar curves showing the distribution of light from lamps giving 1,000 to 3,000 candles are presented.

Of the total of 2,293 units, 1,030 are of the three-lamp type, 581 using 600 c.p. lamps and 413 400 c.p. lamps, whilst a few lanterns carry groups of three 1,000 and 1,500 types. A view is also given of the Holophane unit utilized in the Place d'Italie and elsewhere.

Diagrams for the Place d'Italie show values of illumination ranging from 7 to 12 lux, thus showing uniform high illumination. Similarly in the Rue Royale values from 10 to 30 lux are recorded. In Figs. 2 and 3 photographs taken by artificial light in the Rue Royale and Avenue Daumesil are reproduced.

A final diagram in the original paper shows how greatly the public lighting of Paris has increased during recent years. Throughout the period 1914 to 1921 there was little change in the number of lamps and energy consumed. But since 1921 the number of electric lighting fittings has risen from 2,440 to over 5,000, and the power consumption from 1,089 to 3,300 kW.

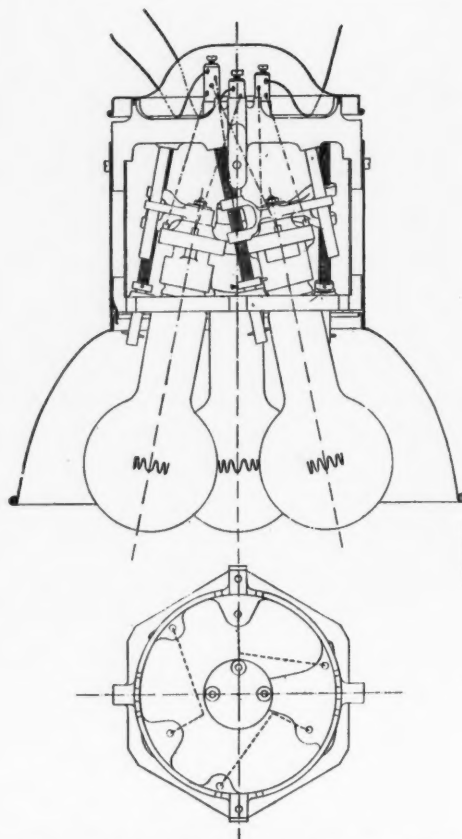


FIG. 1.—Brandt and Fouilleret Lighting Unit for three gasfilled lamps (300 to 1,500 candle-power).

### The Essentials of Good Street Lighting

The attention of readers may be directed to a useful analysis of the above question, contributed by Mr. L. B. W. Jolley, M.A., to *World Power* and since reprinted. Part I is devoted to a discussion of how constancy of illumination is affected by voltage drop along the feeder and variations in the voltage rating of the lamps themselves. Part II reviews the constant current and constant potential systems, their merits and drawbacks. Under the heading of "Architectural and General Design" such matters as position, height of light sources, etc., are considered. It is justly pointed out that pleasing design of posts is too often overlooked. It must be remembered that lamp-posts are even more visible by day than by night. Many existing standards are unsightly, or, at best, add little to the architectural amenities of the town. It appears that the general tendency is against island posts on account of the difficulty in laying and maintaining cables. Similarly, provided streets are not too wide the practice of having all posts on one side of the highway is becoming more common. This arrangement does not detract very greatly from evenness of illumination; on the other hand, it has obvious advantages from the standpoint of installation and maintenance of feeders. Avenues with trees on the kerb-line require special treatment, and here only two courses are available, i.e., (1) brackets projecting beyond the trees into the road and (2) central suspension. Probably these two methods should only be used in special cases otherwise than in avenues; but in this instance they seem preferable. The general feeling of illuminating engineers is in favour of relatively great heights of suspension—as illustrated by the lighting of the Potsdamer Platz in Berlin by means of only four arc lamps on posts 35 feet high.

Fittings and glassware are discussed in considerable detail. It is remarked that "half-opal" or cloudy glassware offers the best opportunities for artistic treatment; but if the opalescent material is too dense all attempts at direct illumination are valueless.



FIG. 1.—Lighting of the Rue Royale, Paris.



FIG. 2.—Lighting of the Avenue Daumesnil, Paris.

## Some Notes on Electric Lighting Developments in Czecho-Slovakia

By Prof. Dr. F. NIETHAMMER (Deutsche Technische Hochschule, Prague).

PRIOR to 1919, i.e., before the Czecho-Slovakian Republic came into existence, the majority of electric lamps used in this country came from Vienna, Berlin and Budapest. In the meantime, however, several lamp factories have been started in this country, the most important being the Osram factory at Prague, a branch of the well-known Berlin company of the same name, which has absorbed the German lamp works of the Siemens and A.E.G. concerns, the "Slavia" lamp works at Brünn (Moravia), the Kremenezky lamp works at Pressburg, a branch of the Vienna lamp factory, and several other smaller lamp works in Northern Bohemia. By all these local factories lamps are also imported, mainly Philips (Holland) and Tungsram (Budapest), prices being regulated by a convention between the chief works.

For the time being we have no Illuminating Engineering Society in Czecho-Slovakia, and no official regulations bearing on lighting. However, lighting problems are occasionally dealt with by the existing technical (mainly electrotechnical) bodies. These bodies are divided into German and Czech societies. Besides six millions of Czechs there are in the Czecho-Slovakian Republic about three and a half million Germans. The Swiss method of co-operation between the various nationalities has unfortunately not been found practicable here.

In regard to practical illuminating engineering work we obtain much information from the German Illuminating Engineering Society in Berlin, whose proceedings are reproduced in *Licht und Lampe*. The German society has worked out various recommendations on illumination. Information is also available from the Austrian Illuminating Engineering Society, whose deliberations are dealt with in *Lighttechnik*, a supplement to the well-known Austrian paper, *Elektrotechnik und Maschinenbau*.

The Hefner candle (approximately equal to nine-tenths of the international candle) is in use in Czecho-Slovakia, as in Germany, Austria and Switzerland. Until last year the only illumination-photometer we had was that of Everett, Edgcumbe & Co. (London). But through the influence of the German Illuminating Engineering Society and the Osram Co. we have now available two very practical types of luxometers constructed by Schmidt and Haensch in Berlin. The smaller of these is very convenient as one can observe directly a bunsen spot mounted on a plane surface; this instrument costs only about £6.

In Czecho-Slovakia we have not only several sheet iron mills but also excellent factories for the production of glass and porcelain, so that there are manufacturing facilities for the production of fittings, reflectors, globes and shades of all kinds. Several firms have illuminating engineers who have devoted themselves to the development of fittings giving the most efficient light-distribution, with absence of glare. The "Wiscott" mirror-reflector supplied by the Osram Co. is very serviceable for shop windows, and similar effects are produced by the Zeiss and Goerz parabolic mirrors. Körting and Mathiesen (Leipsiz-Lautsch) and Dr. Schneider & Co. (Frankfort) specialize in lamp fittings, and the well-known electrical firms such as Siemens and the A.E.G. have also special lighting departments. "Daylight" lamps are used in special cases, and for advertising lighting, signs, etc., the neon tube is now widely used.

Electric miners' lamps are now to be found in many of our coal mines.

In 1912 I was responsible for the lighting of the large new boiler shop of the Erste Brünnner Machine Co. at Brünn. This was lighted exclusively by a considerable number of 1,000 candle-power incandescent lamps, mounted high up. Soon afterwards various textile mills at Brünn and elsewhere likewise introduced general lighting by 100- and 200-watt lamps, yielding an illumination of 40 lux\* without glare. In the new spinning mill of Paul Neumark at Brünn an illumination running up to 100 lux was obtained. This result was obtained mainly by using 200-watt lamps with reflectors and frosted globes. The installation is also remarkable for the fact that no fuses are used, all lighting and motor circuits being exclusively protected by small automatic overload switches. Formerly along each working area there were sixteen or more small glowlamps with bare bulbs, hanging quite close to the eyes of workers, and leaving most of the room in darkness. Now by substituting five 100- or 200-watt lamps, properly screened, on the ceiling corresponding to each area, we give an illumination sufficient to render the rooms apparently as bright as in the daytime.

The main streets of our principal towns are well lighted by high candle-power lamps, and in some of our restaurants, shops and factories bright lighting is to be found. There is also much effective show-window lighting and many illuminated signs. Yet much remains to be done to obtain efficient and agreeable illumination in all private houses, shops, factories and streets. In the rural districts electric light is little used; there are some peasants' houses where the voltage coil of the electric meter consumes more energy than the lamps installed! The use of the arc is now practically confined to searchlights and projectors for moving pictures. Parabolic mirrors and searchlights used mainly for military purposes have been built by the well-known Kolben Electric Co. at Prague—Vysocan—for more than twenty years.

At the German Technical University in Prague regular lectures on electric lighting and heating are delivered. In the electrical laboratories lamps and fittings are tested by students. Test work on lamps for industrial and practical purposes is also done. There are three other Technical Universities, where similar courses on electric lighting are given.

Last winter we had the benefit of a visit from a leading illuminating engineer from the United States, Professor F. C. Caldwell, of the Ohio State University. He spent the whole winter with us and delivered complete courses of lectures on illumination to the students at the Czech Technical University and to the members of the Czecho-Slovakian Electrotechnical Society, all being delivered in German. The lectures have also been published in the Czech language. We were also glad to welcome Professor Caldwell at our German Technical University, and admired the great progress that has been made in illumination in the United States. He gave us an excellent survey of the requirements for efficient and agreeable lighting, and his illustrations of the lighting of interiors, the "White Way" method of lighting American streets, and anti-dazzle headlights and special lamps for railway signalling were of great interest. We were also much interested in the examples of the flood-lighting of large buildings—a form of lighting that is practically unknown here. Professor Caldwell also lectured at Brünn and Vienna.

\* Roughly four foot-candles.

## Report of the Chief Inspector of Factories and Workshops for 1924

THE Report of the Chief Inspector of Factories for the past year makes interesting reading, and illustrates the very wide scope of the activities of the Home Office Factory Department. In the main, one sees evidence of progress. Welfare schemes continue to be developed, and employers in general willingly adopt suggestions tending to eliminate causes of danger to health and safety. In many cases "safety-first" methods have given good results. It is to be noted, nevertheless, that the total accidents reported for the past year, 169,723, show an increase of 44,172 over those in 1923. The fatal accidents, 956, also show an increase of 89. Shipbuilding and building construction are credited with 103 and 104 deaths respectively, and it is remarked that the largest proportion of accidents is due to "persons falling."

Unfortunately this form of accident is very frequently fatal. Analysis of the detailed returns at the end of the report shows that in the shipbuilding industry 64 out of 103 (i.e., over 60 per cent.) fatal accidents were due to this cause. For all industries taken together 290 out of 956 fatal accidents—nearly a third—were due to persons falling. Of all reported accidents, fatal and non-fatal, 22,074 out of 169,723 (nearly 13 per cent.) were ascribed to the same cause.

These results are significant in view of the fact, brought out in the Reports of the Departmental Committee on Lighting in Factories and Workshops, that this form of accident is directly related to conditions of illumination. It is very much to be desired that in the industries where this form of accident is most common special attention should be paid to lighting conditions, and that this point will be taken into consideration by them in the "safety-first" movement, now being initiated in docks.

In our last issue the section of the Report dealing with lighting was commented upon. In what follows, we give this section in full:—

*Lighting.*—The recommendations of the Departmental Committee on Lighting in Factories and Workshops have not been neglected, and during the two years since they issued their Third Report much has been done to bring their suggestions to the notice of employers, and to carry out investigations of the conditions at present existing. There can be no doubt that this question of lighting is exciting greater interest, but perhaps the most striking feature that emerges from the enquiries is the wide inequality found in the standard of lighting, not only in different works, but in different parts of the same works. Such inequality is strong evidence of lack of scientific knowledge, and demonstrates the need for putting forward some standard for the guidance of employers and workers, and for obtaining information as to satisfactory practice which can be made known to the persons concerned.

With such objects in view, representatives of the Home Office have, during the past two years, met representatives of both employers and workers in a large number of industries, and have explained the general principles governing good lighting on the lines of the Departmental Committee's Reports, and have discussed in detail the requirements of the particular industry with special reference to determining what processes might be classified as "fine" or "very fine" work, for which a more than ordinarily high degree of illumination was desirable. These meetings have proved very useful, and both employers and workers have shown great interest in the subject. The offers to send an Inspector, equipped with an instrument to take the readings of the amount of illumination in use for the different processes have been warmly welcomed. Unfortunately it has not been found practicable at present to respond to more than a small number of the invitations received from employers, or to follow up all the suggestions made by the workers, and arrangements made to encourage industries themselves to engage the services of an observer equipped with the necessary instrument have failed for one reason or

another to materialize. A number of readings have, however, been taken by Inspectors while work was going on, and these have yielded interesting results. The instrument used in taking these readings is the photometer, and the illumination registered by the instrument on the actual field of work is expressed by the number of "foot-candles," just as the temperature of a room is expressed by the number of degrees registered by the thermometer. The Departmental Committee recommended that the lighting of factories generally should not be allowed to fall below a minimum of illumination expressed as a fraction of one foot-candle, i.e., 0.25 foot-candles, but for processes which might be classed as fine work, such as sewing, they suggested that the light should not be less than three foot-candles (an amount generally recognized as "a good reading light") and for very fine work should not be less than five foot-candles.

It is of interest, therefore, to find that in factories where attention has been given to supplying a good light for fine or very fine processes, the tests showed the amount of illumination in every case to be over three foot-candles, and in many cases it was above five foot-candles. In tailoring factories and workshops in different towns, 206 readings were taken in the operations of sewing by hand or machines, of cutting and examining the work, and 169 were found to be over three foot-candles, 88 of these over five foot-candles, many being twice that amount.

In fine and very fine processes in hosiery factories, of 60 readings, 49 were over three foot-candles, and of these 42 were over five foot-candles; in one process where a good light is recognized as important because of the close attention required, the factory had been newly equipped with an installation affording an illumination of from 13 to 23 foot-candles for each worker, while in the same factory for the same process the light previous to the new installation was less than one foot-candle. Both employers and workers were delighted with the improved lighting, and found it entirely satisfactory.

Provided that the eyes are protected from glare, the workers appreciate a high degree of light, and, so far as we are aware, no injury is caused to the eyes by artificial illumination of 20 to 30 foot-candles if the light is properly shaded and diffused, but the Inspectors who have conducted the tests lay emphasis upon the need for much greater care in this respect than is commonly exercised. A big problem, and one which, with the raising of the standard of illumination, would be greatly intensified unless the work were placed in expert hands, is that of glare. It is an unfortunate fact that the new lamps fit the old shades, and in many instances where the new lamps were so fitted the results have been very unsatisfactory.

The least satisfactory tests have been those obtained in the spinning and weaving departments of textile factories (other than hosiery). The amount of light provided is, on the whole, low, and there is need for more attention to its equal distribution over the plane of work on the loom or the spinning frame and to the placing of the lights so as to avoid glare on the one hand and troublesome shadows on the other.

In brush making and cardboard box making the majority of readings are below the three foot-candles; in many instances they fall below even the minimum referred to above for general purposes. In these, as in factories and workshops generally, the low readings are not usually due to economy in the use of gas or electricity, but to neglect of upkeep of fittings—gas burners and mantles, or electric light globes and shades being dirty or in need of renewal—or to bad placing of lights in relation to the position of the worker or of the machine; sometimes even a good source of light is rendered ineffective for its purpose by a shadow being cast on the field of work by the person of the worker or by a stack of material, or by a part of a machine or a pillar.

## The X-Ray Examination of Natural and Artificial Pearls

Some years ago, in a demonstration before the Illuminating Engineering Society,\* it was shown how precious gems may be distinguished by the aid of fluorescence under ultra-violet light; in particular, the difference in the colours of fluorescence enabled a distinction to be drawn between Japanese and Oriental pearls. It appears, however, that to distinguish an artificially-cultivated pearl from one of natural growth, but otherwise similar type, is less simple. The distinction here lies mainly in the structure *inside* the pearl, the material being caused to deposit round a central kernel of foreign matter.

It is therefore difficult to obtain vital information on this structure by any optical method based on observation of the outside of the pearl. It appears, however, from a communication recently made to the *Société Française des Electriciens* by Monsieur A. Dauvillier,† that X-ray analysis is of considerable help in solving this problem. Photographs presented shed considerable light on the inner structure of the pearls examined, but the chief basis of distinction is crystalline analysis with monochromatic X-rays; it is then shown that the crystalline structure in the two cases is markedly different.

Monsieur Dauvillier shows that in X-ray analysis we have a new weapon that is likely to prove extremely valuable. Sir William Bragg has shown in this way the difference in structure of diamond and graphite. In other cases useful information may be obtained by studying the permeability of material which is related to the atomic weight of the substance examined. The author shows a galvanometric equipment by the aid of which the homogeneity of an object may be studied whilst in the course of manufacture, or the presence of small quantities of "heavier" constituents determined.

## The Efficiency of "Cold" Light

There is a general impression that most phosphorescent or "cold" sources of light are marvellously efficient, chiefly because they are presumed to emit only visible light and no heat rays. The firefly is the classic example of such an illuminant. But in reality very little, beyond the fact that its light is concentrated in a narrow band in the spectrum, is known about the firefly's radiation, and the examination of radiation from all these such feeble sources is attended with great difficulties. These considerations are suggested by a recent paper read by Dr. E. Q. Adams before the Illuminating Engineering Society in the United States. The glow from phosphorus was selected for critical examination and the view was formed that in this case, at any rate, the efficiency was far below that of an ordinary gasfilled electric lamp.

## Forthcoming Papers on Public Lighting with Gas

It will be recalled that, following the report on the activities of the International Illumination Commission presented by Mr. Watson and Mr. Dunn at the annual meeting of the Institution of Gas Engineers, the hope was expressed that the Institution would take a keen interest in illumination, and especially public lighting with gas. It is therefore of interest to note that the Council of the Institution has decided to arrange for two papers to be read in connection with the Public Works, Roads and Transport Congress to be held during November 19th-26th. The two papers to be read are: "Public Lighting by Gas, with special reference to Automatic Systems," by Mr. C. S. Shapley (Leeds); and "The Valuation of Gas Undertakings for Rating Purposes," by Mr. G. E. Ebetts (London). The possibility of arranging a further paper on the use of tar for road-surfacing is also being considered.

We hope that the Institution will take advantage of any other opportunities that occur of impressing on the public the importance of good public lighting.

\* *Illuminating Engineer*, December, 1921, p. 231.

† *Bull. Soc. Française des Electriciens*, March, 1925, No. 43, p. 215.

## The Efficiency of Light Production

It not infrequently happens that some writer in the press, made aware for the first time of the low absolute efficiency of our present illuminants, jumps to the conclusion that the lighting industry has lagged behind others in the march of progress. He is told that the luminous efficiency of a modern lamp is no greater than 10 per cent., and compares this with over 90 per cent. attained in a modern dynamo. He forgets that a gas lamp or electric lamp is dealing with "mob-energy," that the process of conversion is much more radical and complex. The essential thing for the public to realize is that although the luminous efficiency of modern illuminants is still low, the advances during recent years have been very considerable. The phrase quoted in a recent issue of *The Electrical World* that "to light a lamp as a source of light is about as wasteful as to burn down one's house to roast one's pork" has, allowing for exaggeration, a certain modicum of truth in it. But the gasfilled lamp produces roughly five times as much light for a given consumption of electricity as the old carbon filament lamp, and this is surely a remarkable advance.

Light, indeed, is one of the very few things that has grown progressively cheaper during the last twenty or thirty years. Possible diminutions in the price of gas and electricity are of small moment in comparison with the improvement in illuminants by which the public has benefited. If the absolute efficiency is still low, here is room for encouragement. Further discoveries may yet cheapen light considerably; whereas the possibilities of increased efficiency in many other directions—for example, in electric generators—have been almost exhausted.

## Inaudible Sound-Waves

Whilst we are mainly concerned with light-waves, both visible and invisible, it is sometimes interesting to note what is transpiring in other fields of work—for instance, in the use of waves of sound. Some very curious researches were recently described in *La Revue Hydrographique*. Just as illuminating engineers have had their attention drawn to the fact that ultra-violet invisible rays have many useful applications, so it is being found that "ultra-audible" sound-waves have their uses. Sound-waves, as is well known, are longitudinal, whereas light-waves are transverse vibrations. They cease to be audible at frequencies somewhere between 10,000 and 20,000 cycles per second. In France experiments have been proceeding on the effects of waves of inaudible frequencies between 40,000 and 100,000, originated by means of a three-electrode oscillating vacuum tube. The emitted power may be considerable. With a transmission of about one kilowatt through water, fishes in the path of the beam were killed. Apparently there is no difficulty in confining such a beam under water, and there is little loss by dispersion. By noting the time elapsing between the emission of an impulse and the echo the distance of the reflecting object (e.g., a sunken rock, or the ocean bed) can be calculated. It is therefore believed that the method will prove valuable for geological and hydrographic purposes, e.g., in the laying of cables, and for the location of other vessels, icebergs, shore line, etc., at night.

## An Instrument for Transmitting Light and other Radiations

In the *Journal of Glass Technology* there is reference to a novel optical device, patented by Mr. E. R. Berry, of Massachusetts, U.S.A., and assigned to the British Thomson-Houston Co., Ltd., of London. The device consists of a flexible tube comprising a series of quartz members, by which radiation at one end of the tube may be conducted to the other. The tube can be bent into any form, and the terminating quartz member may be pointed. One use suggested for the device is the exploration of cavities in the human body, light being transmitted from an external source.

## POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—  
Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

### Some Notes on Electric Lamps No. 8

#### LAMPS ON ALTERNATING CURRENT CIRCUITS OF LOW FREQUENCY

By W. J. JONES, B.Sc., A.M.I.E.E.  
(E.L.M.A. Lighting Service Bureau).

IT is common practice in large power installations for the electrical energy to be supplied with a low frequency; in some cases the frequency being as low as  $16\frac{2}{3}$  cycles per second. A frequency of 25 cycles per second is comparatively common in this country in large industrial areas, and although this frequency has its advantages from the point of view of power transmission and power utilization the flickering of the light from an electric lamp is distressing.

This flicker is caused by the alternate heating and cooling of the filament of the lamp, the filament being of sufficiently low thermal inertia to follow each cycle of the electrical energy supply to it. The alteration of intensity of light produced has been found to have a deleterious effect on the eyesight of the operative, rapidly producing severe eyestrain, since the eye tries to adapt itself to the varying intensity of light and the muscles of the eye are continually in movement.

There are two ways of mitigating this difficulty. The first is to only utilize frequencies which are sufficiently rapid that the modifications produced in the light are not perceptible by the eye. It is well known that there is an upper limit to which the eye can respond to changes of light, and is this fact that makes the ordinary cinematograph possible. It is for this reason that an electric lamp operating on, say, a 50-cycle circuit does not cause any inconvenience. It is, however, not always possible to modify the frequency of the supply for lighting purposes. The method of mitigation in such circumstances is to employ a few large lamps in the place of a multiplicity of small ones, since the thermal time constant of a large lamp does not enable the filament to change in temperature fast enough to keep pace with the cyclic variation of current. The lower the frequency the more marked is this effect. For instance, the substitution of a 200-watt lamp in the place of a 100-watt lamp on a 25-cycle circuit will reduce the amount of the flicker by nearly  $33\frac{1}{3}$  per cent., and the use of a 300-watt lamp would almost halve the variation in candle-power during the cycle.

It is a moot point as to exactly the amount of cyclic variation in illumination that the eye can appreciate, but certainly it can be taken as a good rule that the higher the wattage lamp employed the less inconvenience will be experienced on an alternating current circuit of low frequency.

A number of investigators have come to the conclusion that slight variations of intensity of light are rendered less objectionable by enclosing the light source in diffusing glassware, or a similar result is obtained by the use of "white" lamps. It has also been noted that when the light source makes an angle of  $45^\circ$  with the eye that the maximum discomfort is experienced. Careful attention to these details, and especially that of size of lamp, should permit the eradication of most of the disadvantages of the low frequency supply.

### Electric Light in Factories

NO mill or workshop can afford waste these days, when costs have to be cut down to a minimum; yet, notwithstanding the stringency of the times, much money is being constantly thrown away owing to the maintenance of inefficient systems of lighting. During half the year millions of working hours are passed under conditions of artificial illumination. Overhead charges run on as fast as in daytime, so that it is important to keep the plant going at the same pace. But if the artificial lighting is bad this is not possible. What with glare on the one hand, and deep shadows on the other, the worker is impeded at every step. His eye is in a constant state of fluctuation in its endeavour to adjust itself to the different intensities of illumination. Suppose, for example, a man is working at a bench, as shown in Fig. 1, as long as his gaze is downward his eyes are protected from the glare of the naked lamps by his eyelids, but let him look up for an instant and he is half blinded. Evidently, therefore, he will be put off his job for a few seconds at least, and not only waste time but also run the risk of future eye trouble. Nor does he gain any compensating advantage in the way of rest during these few seconds' check to his work. In a word, under such a system both he and his employers lose money.

Again, on looking under his bench, he will be met by deep shadows. Should he want anything he will have to fumble in the dark and waste still more time. The losses thus occurring in large factories where thousands of workers are employed may easily be imagined.

Such a state of affairs is far from inevitable, however. By means of suitable fittings both glare and deep shadows may be eliminated. These usually consist of dispersive type reflectors fitted with bowl-sprayed lamps. Fig. 1 indicates these, suspended above the glaring lamps, but Fig. 2 shows them in action, while the old equipment is "switched off." Under the new conditions the workshop presents an altogether more cheerful appearance, which must, of course, react upon

those who work in it. All trouble from glare has been removed both by placing the fittings higher and by substituting diffused for raw light. That the benches have not suffered is evident, while the gangways are as light again, and, being free from shadows, are free from danger.



FIG. 1.—Inadequate illumination—glare and shadows.

Figures 3 and 4 illustrate a similar change due to a well-designed installation. Here is shown a room in a paper works. The first picture shows the appearance of the room when lighted by "local" pendants. Patches of light fall on the tables immediately beneath the lamps, but the room as a whole is dismal in the extreme and offers a fine field for accidents. When, however, the newly-installed diffusing units are "switched on" the

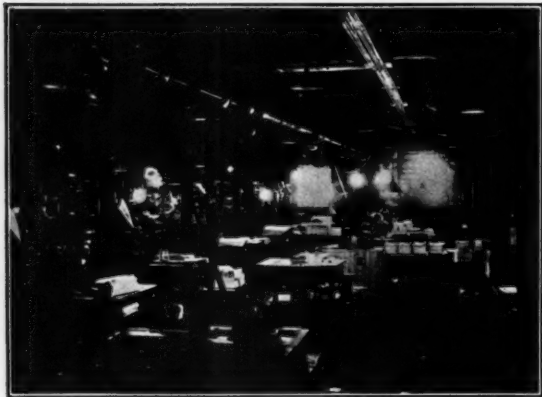


FIG. 3.—A room in a paper works with local pendants and "patchy" illumination.

atmosphere of gloom is at once dispelled. It is now possible to look across the room and see precisely where everything is and what everybody is doing. This alone must mean a great saving in supervision. Again, the moving of materials about the room is at once made far safer and simpler.



FIG. 2.—The overhead units seen unlighted in Fig 1 are now shown in operation with vastly improved results.

Under such conditions a breakdown in machinery is readily traced and the repair effected with the least inconvenience, and, therefore, in the shortest time. Naturally, the arrangement of the lighting points will depend upon the "lay-out" of the workshop, but in a scheme of general lighting the more regular the distribution of fittings, the more even will be the illumination.

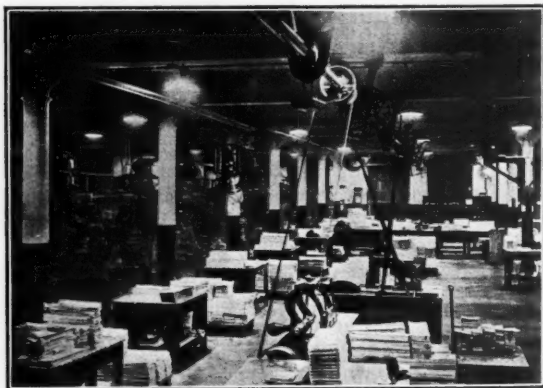


FIG. 4.—The same room lighted by overhead diffusing units giving even illumination and absence of deep shadows.

## Heating Effects in Display Windows

The question has sometimes been raised whether, when exceptionally high illuminations are provided in display windows, the heat from the electric lamps used may not prove inconvenient.

In a recent discussion before the American Illuminating Engineering Society, Mr. W. Sturrock answered this point by giving the results of a test on a window 8 ft. long, 6 ft. high and 4 ft. deep, tightly enclosed so that it had practically no ventilation. This was equipped with seven 500-watt gasfilled lamps in

mirrored reflectors, i.e., more than 60 watts per foot run and about  $2\frac{1}{2}$  watts per cubic foot of space, and sufficient to give illumination bright enough for effective use in the daytime. On a hot summer day the maximum temperature was approximately 160° F. This is considered to be undesirably high, and it is suggested therefore that when very high illuminations are aimed at the lamps should not be enclosed in a confined space, and adequate ventilation for the window should be provided.

## Standardization and the Part it has Played in the Development of the Incandescent Lamp\*

**S**TANDARDIZATION has been cited many times as one of the reasons for the extensive application and low cost of an article which is widely used by the public. It has become a factor of ever-increasing importance to modern industry and is one of the foundation stones upon which large industrial and commercial enterprises are based. In the manufacture of everything from structural steel and automobiles to watches and chewing gum, it plays a large and important part—and in the lamp manufacturing industry, along with all the others, it has become a veritable watchword of progress and service.

Standardization is, by its very nature, a gradual process the beginning of which usually marks a definite stage in the development growth of any idea or invention. The beginning of such a development is woven about a simple device or set of conditions which constitutes the nucleus of the idea. As the application of the idea increases, various means of utilization are incorporated into its design. But each new means of utilization differs in some detail from all the others, so that a decided condition of non-standardization is produced. This condition, however, quite frequently uncovers the best design or at least the best tendency of design for the ultimate product, and therefore has some value in the growth of the idea. The disadvantages of this condition are very burdensome to the manufacturer, and are, of course, a cause of considerable annoyance and inconvenience to the user. Consequently, as the demand increases and as the greater cost of manufacturing such a multiplicity of types and sizes is realized, the manufacturer begins to take definite steps towards the simplification and standardization of his product. This requires a careful study and classification of the requirements which the product must meet in order that a maximum degree of service can be rendered to the user with a minimum number of types, sizes, finishes and the like.

The change from a condition of non-standardization to a definite standardization programme sometimes appears to be a tremendous task because of the complexity which arises when renewal parts or repairs are required for the older equipment. However, that which looks to be a mountain at this period of development will be but a molehill to the ultimate growth and extensive use of the product, for a well-organized and well-planned standardization programme will reduce the "change-over" period to insignificance as compared to the ultimate benefit which will result for the product. This is true because the sole purpose of standardization is to bring about greater economy or greater convenience in the application and use of the product.

Simplification and standardization have a very considerable influence on the unit cost of manufacture for obvious reasons. Moreover, by their aid, it is possible to make a greater concentration of effort towards the improvement of quality. Likewise, this same concentration of effort increases towards a better adaptation of the product to the function for which it was designed, and toward a wider application of the product for other uses.

Standardization also adds greatly to the ready availability of the article because a lesser number of sizes, etc., need be carried in stock, and a larger number of the main sizes, etc., thus results. This enables the customer to receive the quickest of service and relieves him of the tedious process of submitting specifications and waiting for a considerable length of time for the fulfilment of his needs.

The modern method of quantity production would be absolutely impossible without standardization in one form or another.

In the lamp industry the first steps towards standardization were taken more than twenty-five years ago. They were concerned with the base of the lamp inasmuch as they were at least twenty-five types of sockets in use in the late 'nineties and over a hundred different varieties of bases. There was no need for this variety, for most of the bases and sockets were intended to render the same type of service. Consequently, about 1900, a number of lamp manufacturers met together to determine the one best type of socket and base for general use in this country. The socket for the present form of screw thread was then one of the three in most common use, and obviously this was one of the chief factors involved in its selection. Moreover, because of its simplicity and its low cost of manufacture, it seemed to possess some advantages over the other types, of which it was estimated that there were some five million in use at that time. The difficulty of changing these five million sockets so that the Edison screw base could be used exclusively seemed rather large, but after a definite programme had been put into operation the results surprised even the most optimistic. To be sure, the change was effected rather gradually, but no great amount of difficulty was encountered, since the lamps with the standard base were sold with the socket adapters for the same price as the type which was to be eliminated. By this means, and by the gradual scrapping of the old sockets, it was but a few years before the demand for anything but a lamp with a standard base had decreased to an almost negligible amount.

With the adoption of one type of socket and base made standard for all general lighting service, the importance of standardizing the essential dimensions of the base and socket shell diameters, and the depth and form of thread, became apparent, and standards were soon promulgated for the screw-thread bases by the American Society of Mechanical Engineers.

Because of the different sizes of lamps required for the various classes of service, such as general interior illumination, street lighting, flashlights, and small decorative fixtures, it, of course, became necessary to have more than just one size of base. However, even though these four sizes of screw base all serve in different fields, each one is perfectly standardized within its own field.

Because of the vibration encountered, and the necessary accuracy in the position of the light centre, the automotive lighting field presents a different problem. Nevertheless, even in this field there are but two standard types of bases.

The standardization of lamp voltages was another problem encountered in the lamp industry. In the days of the carbon lamp the irregularities in the manufacture of the filaments were such that it was difficult to make any individual lamp conform to any definite voltage specifications. Consequently the completed lamps were tested to an approximate voltage rating and sold accordingly. This then made it possible to obtain lamps for each individual voltage from 100 to 130 volts, for the more common uses. The central stations in various communities operated on different voltages; hence the lamps which happened to fall within any particular voltage range were used in the particular community which maintained a corresponding voltage. Thus all lamps were used on voltages approximating their own rating.

Previous to 1910 no effort was made to restrain the spread of the voltages within the 100- to 130-volt range, but by 1913 it had become possible to manufacture lamps accurately to any desired voltage, so that after this time voltage standardization became a matter of considerable interest. Through co-operation with the companies producing and distributing electricity, 93 per cent. of the lamps in this range are now supplied to circuits of either 110, 115 or 120 volts, and the demand for lamps of some voltages has entirely ceased. Even to-day voltage standardization is not complete, but it is entirely possible

\* Abstract of a Report of the Lighting and Illumination Committee, reproduced in the Journal of the American Institute of Electrical Engineers.

that 115 volts will eventually become the standard voltage for all lamps intended for general lighting service. This will simplify certain parts of the process of manufacturing and distributing lamps, and the economies thus attained will, in due course, react to the benefit of the ultimate consumer.

To-day practically every important type of lamp used for general lighting service may be obtained with one or more kinds of bulb finish. Moreover, the various bulb finishes have come through a period of general development, the same as has been the case with the other items involved in the manufacture of lamps. These finishes, excepting the colour-sprays and the like, have had for their object the diffusing of the light produced by the filament with partial concealment of the latter so as to reduce the glare resulting from the bare filament. Prior to this time, these objects have been accomplished by several different means, among which were the outside sand frost, the outside spray frost, the use of white opal glass and the use of white enamel. All of these, with the exception of the opal glass, are finishes applied to the external surfaces of the bulb, and are therefore more or less hard to keep clean.

The latest step in the development of the bulb finish has but recently been announced by the lamp manufacturers. It consists of an *inside frost*. This frost, inasmuch as it is inside the bulb, leaves the outside surface perfectly smooth—the same as the case with clear lamps—so that the lamp may be cleaned very easily. Moreover, the nature of the inside frost is such that the loss of light through cross reflections inside the bulb is much lower than in other types of diffusing bulbs; consequently the efficiency of transmission is more nearly that of a clear bulb than any other diffusing finish.

On July 1st, a new 25-watt frosted lamp was introduced to the buying public. The inside frost reduces glare quite considerably, and even though a distinct bright spot is apparent in the centre of the bulb when lighted, yet the relatively great contrast in brightness which exists when ordinary frosted or coated lamps are viewed against the darker background is considerably reduced with the inside frosted lamp. Consequently little or no choice remains between these two types of lamps from the standpoint of glare.

Now, if real progress is to be made in the attempt to reduce materially the number of types of lamps regularly supplied, it would be advantageous to produce a lamp combining the best features of both the clear and the frosted finish. This inside frosted lamp may perhaps be the solution of this problem.

A glance at a historical collection of incandescent lamps will reveal the large number of bulb shapes and filament constructions which have been used at one time or another. Even to-day, there is a considerable variety in bulb shapes. Therefore, if a single shape of bulb can be chosen to replace the several varieties now in use, another step towards complete standardization will have been made. The new lamp mentioned above has many possibilities when considered from this angle. It approaches more nearly a "drop shape" (such as would naturally be taken by the dab of glass from which it is blown) than any of the other bulbs, and it is for that reason very good from the standpoint of bulb production. In addition, it is sturdy, beside presenting a very pleasing appearance when viewed from an artistic point.

The greater mechanical strength of the coil filament lamps, first introduced as Mill Type lamps, and the higher efficiency which it is now possible to obtain from their use, has ensured the coiled filament of being one of the important items in any further standardization developments.

In concluding, it might be interesting to note that lamp standardization in this country has, in spite of an increase in the former range in lamp sizes of from two to 32 c.p., as compared with the present range of from 10 to 1,000 watts, reduced the total number of different varieties of the more common types of lamps, considering the various combinations of size, shape, voltage, and finish, very considerably, and a further reduction in the number of sizes, etc., may be expected in the future.

## The Lighting of the New Gallery Kinema

The lighting of the New Gallery Kinema (Regent Street, London), is another example of the modern tendency to make use of colour effects. The chief feature of the main entrance hall (Fig. 1) is the illuminated dome, in which a large number of white Osram

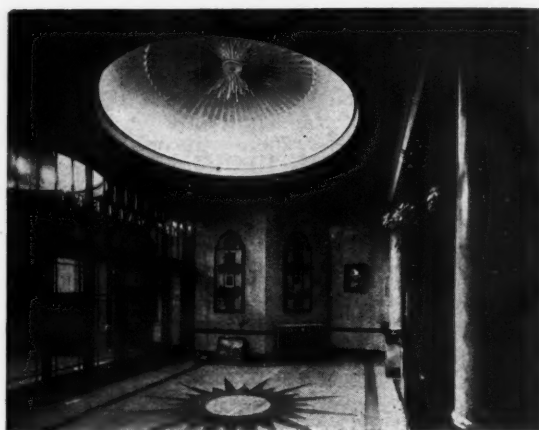


FIG. 1.—View showing the Illuminated Dome in Main Entrance.

lamps are concealed. Behind the ferns and flowers on the top of the pay-box there are Geco Ray reflectors equipped with 100-watt Osram gasfilled lamps. The exterior of the main entrance is effectively lighted by G.E.C. floodlight projectors.

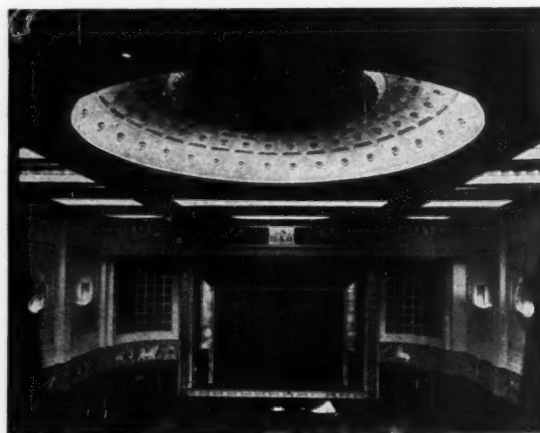


FIG. 2.—View of Auditorium.

The auditorium dome (Fig. 2) is illuminated by concealed Osram colour-sprayed lamps in red, blue, green and yellow. By the aid of dimmers a wide variety of mixed colours can be obtained. A special feature is to be seen on the sidewalls, where the lighting units take the form of old-time wooden ships with sails, both gilded. For stage lighting a special footlight system, with 30-foot compartments, is in use; this system was specially designed by the Illuminating Engineering Department of the General Electric Co., Ltd.

## Lighting Fittings for the Modern House

THE following illustrations give a fair idea of the beauty and efficiency of gas lighting fittings for various rooms in the modern house. They show that, by the exercise of taste in the choice of both the fittings and the shades, gas pendants and brackets can be made to enhance the appearance of

a room during the daytime as well as during the dark hours. Great care was taken in the placing of the lights in these rooms, and anyone who is about to arrange the lighting of a house would do well to study the illustrations in detail, as they embody many useful suggestions.



FIG. 1.—A fine panelled entrance hall, copied from an old house formerly at Bexley, Kent, dating about 1750. The gas pendant and brackets are beautiful imitations of candle lights, and are turned on and off by switches.



FIG. 2.—The gas pendants and bracket in this modern kitchen are arranged so that there shall be ample light at all working points, namely, on the gas cooker, the ironing board, the kitchen cabinet and the table. The sources of light are shaded by means of milk-white silica shades.

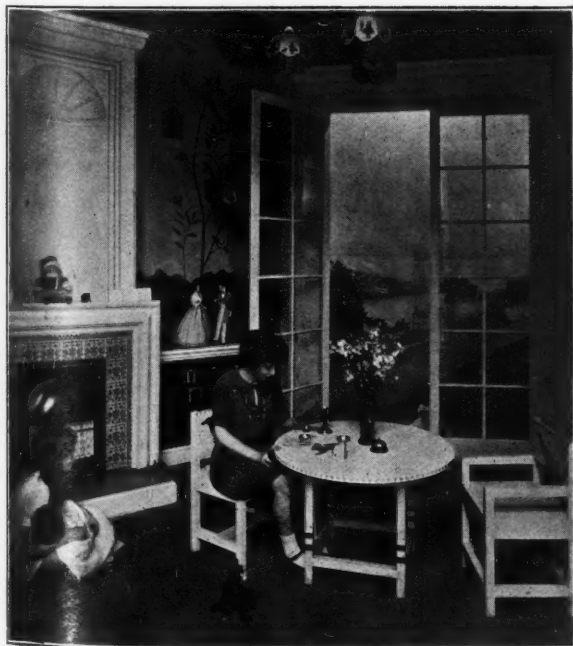


FIG. 3.—This children's nursery is lit by inverted incandescent gas lights with silk shades ornamented by quaint silhouette figures. The burners are turned on and off by a switch placed near the entrance to the room.



FIG. 4.—A library containing some fine furniture of the seventeenth century and a quaint old brick fireplace. At the side of the fireplace is a simple but beautiful silk-shaded, inverted, incandescent gas bracket.



FIG. 5.—A comfortable bedroom boudoir, the charm of which is due to no small extent to the gas lighting brackets, pendant and table lamp, with their delightful shades in colours which harmonize with their surroundings.

FIG. 6.—A children's bathroom, with the bath slightly sunk in order to make it easier for the little people to get into it. The gas lighting fitting chosen for this bathroom is of the semi-indirect type, which ensures a very even diffusion of light.

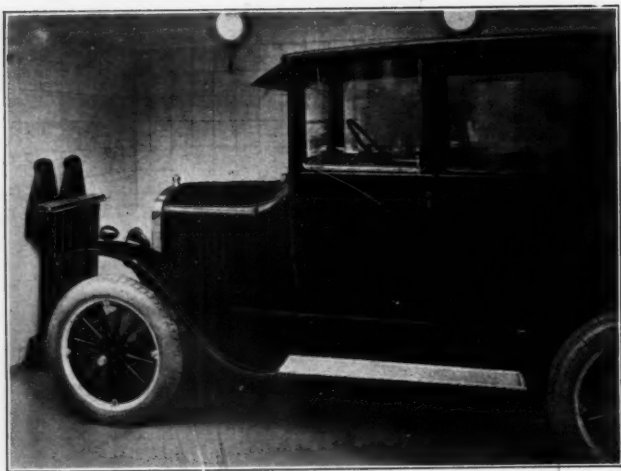
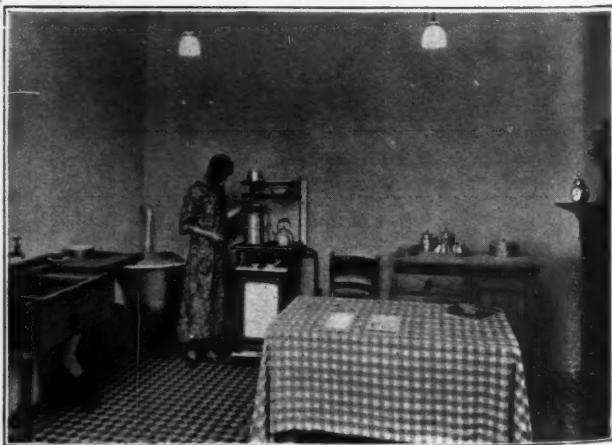


FIG. 7.—A garage lighted by specially-designed wall gas lights which, owing to the method by which they are enclosed, cannot ignite the fumes of petrol. These lights protrude but a small distance from the wall, and are so fixed that they cannot be damaged by an unskilled movement of the car.

FIG. 8.—The chauffeur's kitchen, very simply but well equipped, and lighted by two quite inexpensive gas pendants fitted with efficient inverted incandescent gas burners. The shades give a good diffusion of the light throughout the room, and ensure ample illumination at the points where it is most required.



## The Lighting of a Modern Printing Works

Where "The Illuminating Engineer" (The Journal of GOOD LIGHTING) is now being printed

By LOUIS LACEY

*THE ILLUMINATING ENGINEER* is printed at the factory here described, that of Taylor Garnett Evans & Co., Ltd., Guardian Printing Works, Cheetham, Manchester (situated about one mile and a half north of the Manchester Royal Exchange), and it is perhaps fitting that a journal devoted to better lighting should be produced in a factory which has had some thought given to this important matter.

These notes are not intended to be a technical exposition of the science of illumination, but rather to

In building a new factory of the one-storey type the first essential is to secure the maximum of good natural light. The factory illustrated consists of a two-storey administration block, and eight bays running east and west, and lighted on the north side of a "saw-tooth" or weaving-shed type of roof, the northern slope being the shorter and set at a more acute angle than the long or southern slated slope.

An unusual angle was selected, which gave a great depth of glass, about 12 feet (two sheets deep), fixed in



Machine Bay No. 4, looking east.

describe a practical attempt to solve the problem of lighting, both natural and artificial, to enable the best colour printing to be done under proper conditions. The works were constructed in 1920.

The writer unfortunately did not then know of the existence of the Illuminating Engineering Society and of the mass of data which it has so carefully built up during its years of activity; he is thus now able to testify as to the great help which can be given to the non-technical executive of an industrial undertaking who may be faced with these problems, and who would be greatly helped by the knowledge and experience which the Society can place at his disposal.

It is true to say that architects, builders and electrical engineers do not always seem to have that precise knowledge required, nor appreciation of the problems involved in the correct lighting of a factory which probably has many varied requirements of illumination under the one roof.

Pennycook's patent lead glazing bars. The result of this depth is shown in the fine quality of the natural light obtained. This is further enhanced by the long southern slope being painted white on the inner side with oil paint, so providing a large reflecting surface which materially assists the lighting power of the northern glazed slope. It may be here mentioned that the southern slope is lined with felt just beneath the slates, which serves to keep the factory cool in summer and warm in winter.

At the end of each bay, which is 225 feet long, is affixed a Roman-arched window, 15 feet wide at the base. These windows run round each side of the building save on the western front, where the windows are very high, about 15 feet, as to a portion of the elevation which is factory proper, and suitably modified and spaced to two rows in the office portion of the administration block, which is elevated three feet above the level of the main factory to give oversight over the whole area.



Battery of Linotype Composing Machines.

The arched windows serve to overcome a grave objection to a north-lighted "saw-tooth" factory, which is this: No matter how good a top light may be, it is not good for the worker to feel imprisoned and never to see the sunlight.

Sunlight cannot enter these arched windows to a degree which makes working near the windows uncomfortable, but it can be seen and felt, and there are views possible; sections of the windows can also be opened to admit air; fine printing can be judged accurately against the light of these windows, and operations connected with the preparation at machine of fine half-tone engravings can be carried out easily.

The walls are lined with white glazed bricks, which also have very high reflecting power in addition to a continuously clean and bright appearance. They also settle the decoration problem finally, since they only

require a rub down with a damp cloth from time to time to keep a uniform standard of cleanliness and reflector efficiency.

The exposed steelwork of roof is painted a delicate azure blue, which helps the effect of good light.

There are no interior walls; the departments are separated by clear glass screens, which allow light to pass across the building from side to side or end to end.

It is interesting to note that the photographs here shown were taken in mid-winter—at the end of December, 1923.

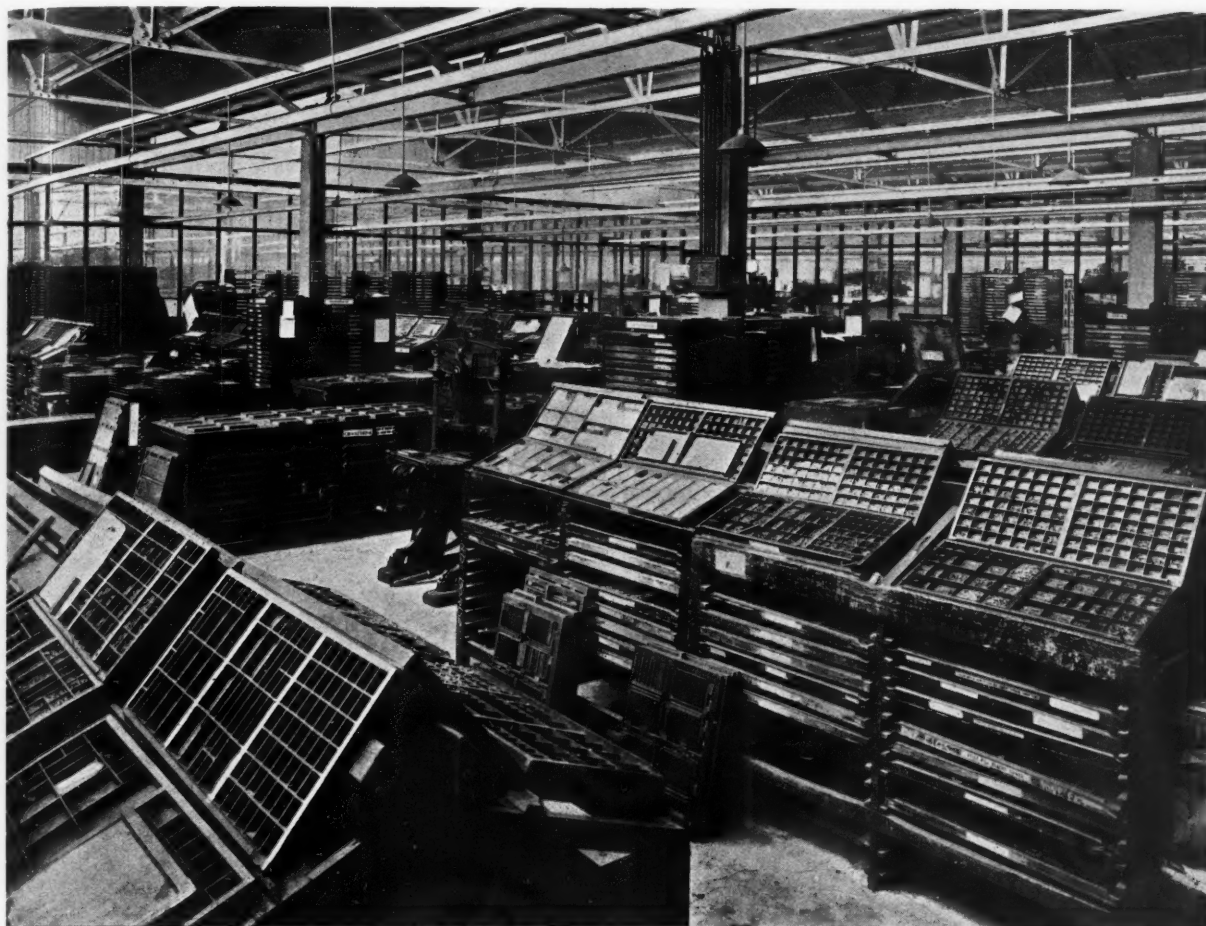
It is not necessary to tell readers of this journal of the great difference in the quality of mid-winter daylight as compared with summer; yet these *untouched* photographs are perfect and show the lighting as being so strong that, unless this point were made clear, they might be assumed to have been taken on chosen summer days. There is no doubt whatever that airy, well-lighted rooms do help the worker very greatly, and a bright, happy, healthy worker is a good worker. So in planning a factory, do not shut out the view entirely; allow the sunlight to be seen, whilst protecting your people from discomfort, especially from southern or western roof-lighting.

The gangways or passages between the lines of printing presses are very ample and are flooded with light, consequently there have been no mishaps when handling delicate and fragile frames (or "formes") of type and copper blocks or other illustrations, and there is no risk of accidents on or among the machines themselves consequent upon heavy shadows, which are happily non-existent.

Another advantage of a full field of light is that the control of the factory is made possible from a central platform, elevated three feet and common to all depart-



South-west Corner.



Part of Composing Room.

ments, being sufficiently separated for administration purposes by the junction of the glass screens. It is thus very easy for the foremen or staff to see each other, or particular individuals they may wish to interview regarding the progress of work, and so the time of highly-paid men is saved and work expedited.

Having secured very good natural lighting, it followed that the artificial lighting should come somewhere close to this high standard. At once will be perceived the value of such a standard; it enables work by daylight to be continued much longer than would be the case with indifferent lighting; the factory can, in fact, continue about one hour longer than the average multiple-storey city factory within a mile of it.

Electric light was a matter of course in an area such as Manchester. High-tension 3-phase alternating current is taken from a Corporation power station and passed through a Ferranti transformer, which brings it down to 420 volts. A sub-station is installed in the centre of one side of the machine room, forming part of the room; four motor-generator sets of varying horse-power are here placed on concrete island bases three feet thick, which are, in principle, isolated from the main floor, and so not able to receive or give vibration.

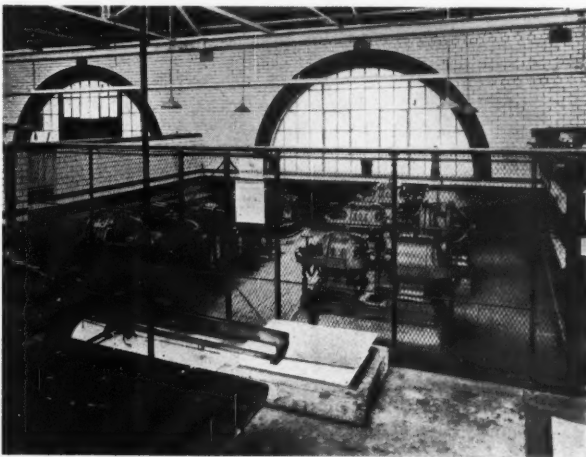
These sets are used singly or in parallel according to the load, the electrical engineer in charge constantly watching the activities of the machines, some 55 printing presses and 45 light operation machines such as folding, stitching, etc., and gauging his supply accordingly. The 420-volt alternating current is converted into direct or continuous current of a very low voltage, 110, which has been found very efficient, and also safe, for printing machine use, and especially for variable-speed work. The distribution board is arranged to deal with one or all sets at once, and passes the current by an overhead

installation to all parts of the factory, dropping down steel tubing to each machine.

The steel stanchions which support the roof are spaced at intervals of 25 feet by 25 feet. They are cased in concrete with a smooth cement face added, and serve admirably to hold the controls and boxes.

The carriage of the steel pipes containing the lighting cables is arranged thus: Down the whole length of each bay run two lengths of wooden supports (3 in. by 3 in.) slotted to fit the tie bars and cut at the ends to fit into each other; they are to be clearly seen in the photographs.

These wooden supports are quite strong enough to carry the tubing. The light points are arranged to fall over the feed end of the machine and over the delivery end. The long bays permit of an almost uniform spacing—about 12 feet separate the lines of



Sub-station.



Machine Bay No. 3, looking west.

wooden supports. The tubing is so arranged at light points to permit of three-feet lateral movement either way in case a machine be moved. Small or platen machines have each a light point.

The wooden supports are so placed on the tie bars as to be almost equidistant, with roughly 12 feet between, both down bay centre and from one bay to the other. Consequently, as the stanchions are at 25 feet intervals the lighting plan "rends" almost the same north to south, as east to west; this makes for even lighting, the glass partitions also playing their part to this end.

The lights were fixed at such height as to cut out glare and give a uniform field of light with minimum shadows. For small machines and some fine operations the lights were arranged on the adjustable principle as required.

It was considered that local-general lighting was the most suitable for a printing room, with certain "adjustables," and also a "flexible" to each press to enable the operative to get anywhere and see anything on type forme or bed; this "flexible" is indispensable in a printing room, and the low voltage makes it a very safe appliance in the hands of the most careless; a serious accident to a worker is not possible. The 200 candle-power gasfilled  $\frac{1}{2}$ -watt lamps are fitted in suitable reflectors, which might be further improved with a drop side to cut out any risk of glare. As printers work so much on the white paper, excessive artificial lighting defeats its own object, and so a happy medium has to be chosen. An average of about six foot-candles, supplemented by flexible units as described above, gives all the light needed for fine operations, and a lesser standard suffices for watching the delivery and feeding of white paper. A specially designed powerful lamp, fitted with lenses, reflectors and blue glass, is provided near supervision platform for the foremen to judge colour accurately. There is no overhead shafting or belting, the "individual drive" principle being used.

The current consumption is exceedingly low for a large factory such as this, and the "maximum demand" plan

has been found excellent and economical, providing plant and peak-loads are watched incessantly by a careful and practical electrician.

Parts of the factory and offices which may have to work overtime are placed upon the alternating current supply to avoid the need and expense of running the sub-station at such hours. In the case of the linotype composing machine it is necessary to have a carefully-screened light placed directly in front of the operator to give him sufficient light.

The important factor for master printers engaged upon similar high-grade colour work and upon the production of letterpress which must be perfectly printed is to remember that the cost of good lighting is comparatively a small matter. In this instance the percentage of cost upon the wages and salaries bill is considerably less than one per cent. and this calculation takes in the office and studio lighting, and the relatively higher figure reached by including the non-productive salaries with productive wages.

When the risk of spoilage, which might easily happen with bad lighting, is considered, the value of effective lighting is at once realized, for one spoiled colour job of any magnitude might easily equal in value, or surpass, a whole year's lighting bill. Printing machine minders engaged on colour work must be something more than clever craftsmen-mechanics, they must have a knowledge of colour and an artistic feeling for correct harmonies and colour matching; but they cannot successfully carry on this difficult and exacting work if not aided by good natural light, followed by adequate artificial light. The three-colour process rests upon the theory of the exact selected shades respectively of yellow, red and blue being maintained, and also that the quantity of ink does not vary to a greater or lesser degree. If variations are permitted to occur in any or all of these three primary colours the differences perceptible in the finished result may be very great; hence the absolute necessity of good lighting to the colour printer.

## TRADE NOTES & ANNOUNCEMENTS

### THE FLOOD-LIGHTING OF A NEWSPAPER OFFICE.

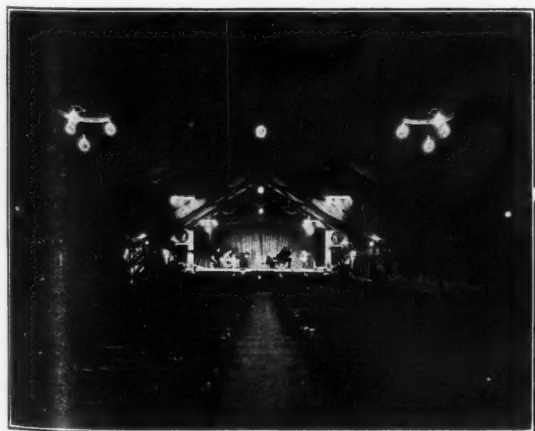
Another good example of flood-lighting, the illumination of the tower of *The Sheffield Telegraph* building, is illustrated in the accompanying illustration. This building is situated in the High Street, right in the centre of Sheffield, and, being covered with glazed light-coloured stone, lends itself particularly well to flood-lighting.

The installation was designed by the British Thomson-Houston Co., Ltd., and the work carried out by the Borough Billposting Co. Eleven B.T.H. flood-light projectors are used. Seven of these are mounted on the flat roof and trained in such a way as to illuminate three sides of the tower. The other four are mounted on the roof of another building on the other side of the road, and serve to illuminate the front of the tower. Each of these projectors is equipped with a 500-watt Mazda gasfilled projector-type lamp.

*The Sheffield Telegraph* building stands on high ground, and consequently the illuminated tower is visible from a considerable distance. To a newspaper publicity is the breath of life, and this form of illumination forms one of the most economical and effective methods of keeping it before the public notice. We understand that this is only one of many flood-lighting installations carried out recently by the Company, and full technical information may be obtained on application to the British Thomson-Houston Co., Ltd., at Mazda House.

### LUNA PARK—LONDON'S LATEST ENTERTAINMENT CENTRE.

From the General Electric Co., Ltd., we receive the accompanying illustration showing the stage lighting at Luna Park (situated at the corner of Tottenham Court Road and New Oxford Street), where a programme is being given by the Variety Artists' Federation. The proceeds will be devoted to the reconstruction of the Middlesex Hospital. During the night-time the spacious grounds of the park are illuminated



with Osram colour-sprayed lamps. On the stage general lighting is furnished by eleven area-floods equipped with Osram gasfilled lamps. The stage footlights are mounted in a special trough reflector, one row being of clear lamps, the other of colour-sprayed lamps, which may be used in any desired combination.



Flood-lighting of *The Sheffield Telegraph* Building.

### SIEMENS SWITCHGEAR.

Catalogue No. Z. 103, issued by Siemens and English Electric Lamp Co., Ltd., contains comprehensive details of Ironclad switch and fuse gear. There are three main sections devoted respectively to house service fuses, switches and switch fuses; watertight switches and switch fuses; and knife switches. The watertight variety, in particular, bears evidence of careful design, and is recommended for exposed positions.

### STREET LIGHTING IN TOTTENHAM COURT ROAD.

The above photograph, taken at night, shows the lighting of Tottenham Court Road, where the original arc system has recently been replaced by more modern methods. In the new



Street Lighting in Tottenham Court Road.

scheme 1,000-watt gasfilled Siemens lamps, arranged in series on the outs of the three-wire distribution, are used. The installation is an example of the general tendency to use gas-filled lamps of the higher wattages for public lighting, and the use of a number of these lamps in series is an interesting feature.



FIG. 1.—The Elephant and Castle, 6 a.m.

#### THE G.E.C. "WEMBLEY" LANTERN.

The G.E.C. "Wembley" lantern, which has previously been referred to in this journal, is fully described in a well-got-up booklet issued by the General Electric Co., Ltd. The lantern itself is specially designed to resist watersplash, drifting snow, or mist, and is furnished with an inner refractor giving the form of polar curve best adapted to street lighting. It is made in two sizes intended to accommodate 300/500-watt and 1,000/1,500-watt lamps. The polar curve shows a maximum candle-power of over 6,600 at  $70^\circ$  with a 1,500-watt lamp, and curves for two such lamps mounted 25 ft. high and 100 ft. apart show an average illumination of 2.51 foot-candles, a maximum value of 4.55 and a minimum of 1.35 foot-candles. The "inequality ratio" is thus 3.37—a very moderate ratio between maximum and minimum illumination for street lighting. An illustration in the booklet shows one of the tests carried out on a Wembley lantern to illustrate its weather-proof properties; the lamp being mounted in a chamber and receiving the continuous impact of several jets of water.

At the end of the booklet there are many excellent photographs of installations of these units, night views and day views being shown side by side. The two illustrations above are typical. They show the appearance of The Elephant and Castle as revealed at 6 a.m. and 2 a.m. respectively on the same day.

The overall length of the 300/500-watt type is 2 ft., of the 1,000/1,500-watt type 2 ft. 9 in. The respective net weights of lantern, outer globe and refractor are 17 lb., 6 oz., and 32 lb.

#### THE ILLUMINATION OF SEASIDE RESORTS.

The lighting of seaside resorts is a very reasonable topic, especially in view of the record holiday crowds this year. We notice that at Southend the illumination of the pier, pierhead, bandstand and dancing pavilion are on a much more elaborate scale than in the past. Southend pier is believed to be the longest in the world, being more than one and a quarter miles in length, and is entirely illuminated by Osram lamps, both clear and coloured types being used. A feature in the dancing pavilion is the installation of a number of Wembley lanterns.

#### PHILIPS LAMPS, LTD.—NEW BRANCH IN LEEDS.

We understand that a branch in Leeds has now been opened by Messrs. Philips Lamps, Ltd. The address is as follows: Philips Lamps, Ltd. (Leeds Branch), 4, Park Place, Leeds. (Tel.: Leeds 28339.) Mr. E. H. Armitage has been appointed branch manager.



FIG. 2.—The Elephant and Castle, 2 a.m. (same day).

#### MESSRS. ALLEN-LIVERSEDGE, LTD.

As from August 1st, Allen-Liversedge, Ltd., Victoria Station House, Westminster, S.W.1, are taking over the sole selling agency for Great Britain and Ireland of the Electric Welding Products of Messrs. Buckley, Saunders & Co., Ltd. (Princess Street, Westminster and Birmingham). These include the well-known "Pontelec" Resistance Welding Plant, Electric Rivet Heaters, etc.

#### SOME NOTES ON SHOP LIGHTING.

Under the above title an illustrated "souvenir" of the E.L.M.A. Lighting Service Exhibit at the I.M.E.A. Convention at Brighton has been issued. The commercial value of good window lighting is stated in concise terms, and is driven home by the aid of numerous illustrations, some of which figured in the paper by Messrs. W. J. Jones and H. Lingard ("A Survey of Lighting in 800 Retail Shops"), recently read before the Illuminating Engineering Society.

#### D.P. BATTERY CO., LTD.

##### NEW CATALOGUE.

We have received from the above Company a copy of their new catalogue, which is well illustrated and exceptionally complete, every effort being made to make it a useful book of reference. The cells are listed in order of size, and a feature is the series of sketches showing the method of assembly and dimensions. Attention may also be drawn to the "quick reference" tables which summarize the main details and assist reference to pages on which fuller details are given.

#### CONTRACTS CLOSED.

The following contracts are announced:—

MESSRS. THE GENERAL ELECTRIC CO., LTD.:

*The Admiralty*, 12,000 Osram standard vacuum type lamps.

We are also informed that an extensive installation of Osram lamps has recently been made in the dining saloon of the S.S. "Hildebrand," one of the Booth Line steamers. After a test it was decided to fit the saloon throughout with 110-volt 40-watt white Osram lamps. The S.S. "Hildebrand" uses Osram lamps throughout.



HIGH ILLUMINATIONS AND EYE FATIGUE.

Sir,—The point raised in your note on the experiments of Professor P. W. Cobb and Mr. F. K. Moss in your last issue (p. 184) is a fundamental one. Throughout its development the human eye has been accustomed to the high illuminations of natural light, and the lower values provided by artificial light in the evening are regarded as a transition stage to sleep and darkness. I have heard the suggestion made that it is therefore unnatural to try to emulate the brightness of day by artificial light, and that to do so continually may induce fatigue.

From a practical standpoint I do not think there is very much in this contention. During periods of repose, for example, when resting in our homes in the evening after the work of the day, we do not require very high illuminations. But during the working period it is surely advisable to approach as nearly as is economically possible to the degree of illumination conducive to the greatest ease of work. Few illuminating engineers, I imagine, would consider that an illumination up to say 50 or 100 foot-candles would in itself cause fatigue, provided that the eye sees only objects of moderate brightness, and that severe contrasts and glare are avoided. The researches mentioned support this view, though there is room for discussion of the criterion (muscle-balance) adopted as an indication of fatigue.

A more serious aspect for advocates of high illuminations to consider is that raised in the comment at the conclusion of your note. Granted that relatively high illuminations do not in themselves induce ocular fatigue, and also that by their psychological stimulating effect and by rendering work easier they enable output to be increased, can it be said that this increased output is unaccompanied by fatigue? Better lighting removes handicaps to expeditious and accurate work, so that, assuming the output was the same as before, human effort would be saved, and there should be *less* fatigue. But if the worker is stimulated by the higher illumination to put forth greater efforts, may not this involve some increased strain, even though he is "more efficient"? The objection that might be raised against "super-illuminations" on this ground would be merely part of the general reproach against modern industrial methods—so much more work is done in a given time than during the past that nerves are apt to suffer.

From this standpoint I have sometimes thought that advocates of higher illuminations would be wise to dwell on the fact that it removes needless handicaps to smooth and efficient working, and thus enables things to be done with less effort—rather than upon its presumed influence in enabling or inducing people to get through more work in a given time.—  
I am, yours etc.,  
ENQUIRER.

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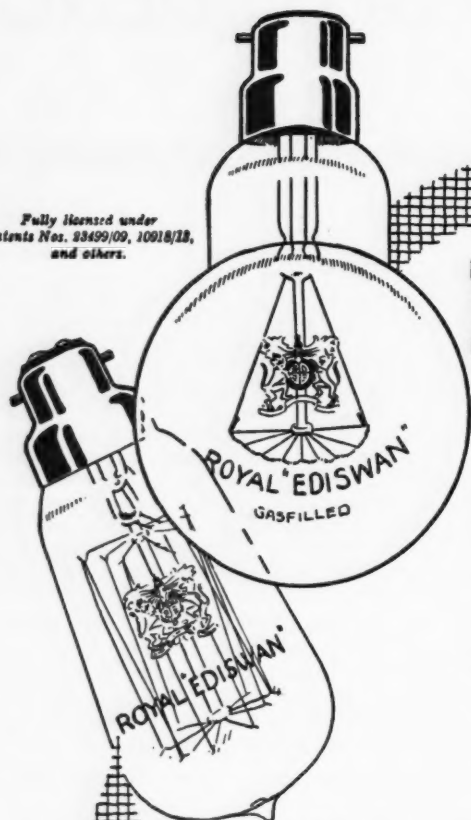
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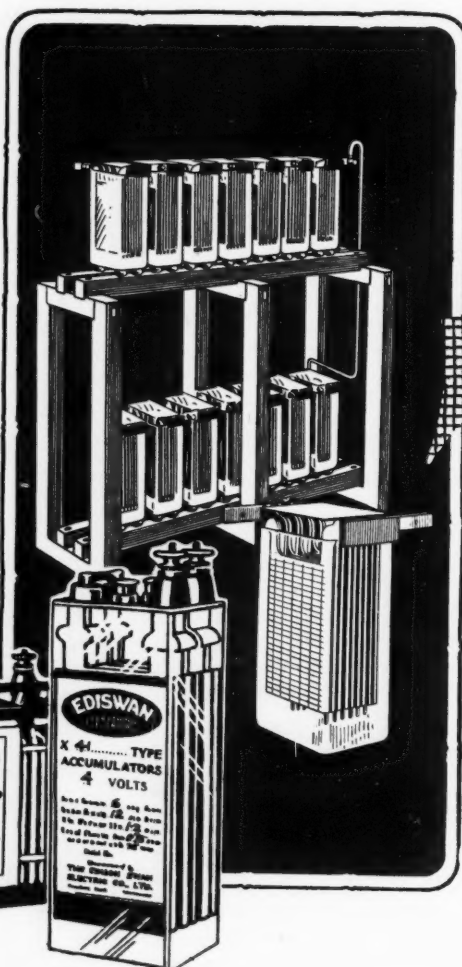
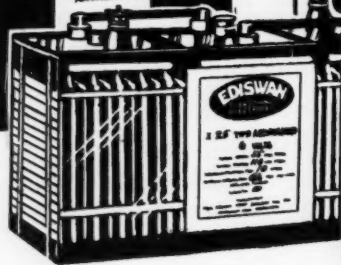
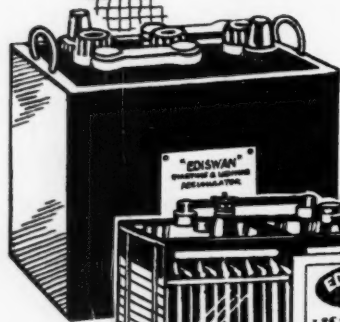
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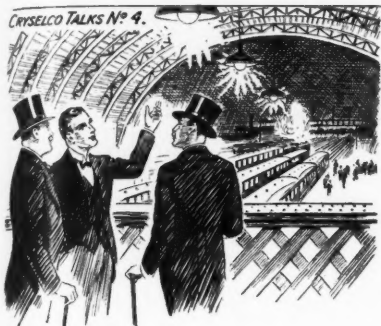
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